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The Eighty-Second Meeting of the American Astronomical Society

By CURVIN H. GINGRICH

At the invitation of Dr. Edwin C. Carpenter, director of the Steward Observatory of the University of Arizona, many members of the American Astronomical Society and their guests assembled in Tucson on Wednesday, December 28, for the sessions of the eighty-second meeting of the Society which continued until December 31. The program of the meeting and the location for holding it at this season attracted visitors and papers from all parts of the United States, Canada, and Mexico. Upon arrival the visitors were welcomed, first of all, by a specially designed folder by the Tucson Chamber of Commerce. This greeting was in the name of "The Sunshine City" whose fine climate is said to provide 336 days of sunshine in the course of a year, and to afford good hospitality and plenty of activity at all times. Later, at the Society dinner, the Chamber of Commerce was again in evidence, this time in the presentation of a souvenir, to each person, the souvenir being in the form of a cow-boy hat made of copper attached to a key holder.

Wednesday evening was devoted to renewing of acquaintances and to informal conversations. The beautifully appointed social room of Yuma Hall, in which most of the visitors were living for the duration of the meeting, was admirably suited to this purpose.

Promptly at the scheduled hour of nine o'clock on the following morning, in a room in the recently completed Chemistry-Physics building, the first session was called to order by the president, Dr. Alfred H. Joy, of the Mount Wilson Observatory. After some preliminary remarks relating to the program of the next few days, Dr. Joy introduced Dr. R. L. Nugent, vice-president of the University of Arizona, who welcomed the visitors to Tucson and the University in the name of the president, Dr. J. Byron McCormick, who was unable to be present. Following this Dr. E. F. Carpenter, director of the Steward Observatory, added the welcome of the Observatory and made important announcements relating to "extra-curricular" activities. Next came Dr. A. E. Douglass, former director of the Steward Observatory, well-known to every one for his pioneering and highly successful work on the determination of astronomical cycles through the study of tree-rings. Among other things, he said that instruction in astronomy was begun at the University of Arizona in the year 1906. During the few days of the meeting many astronomers availed themselves of the opportunity of

THE EIGHTY-SECOND MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY, TUCSON, ARIZONA, DECEMBER 28-31, 1949

examining the exhibits of the work of Dr. Douglass in the museum and in his laboratory. Dr. Douglass usually was present and graciously explained the nature of his studies and the results accomplished. Although nominally retired, Dr. Douglass still shows the enthusiasm and zest of a young man just entering upon his life's work.

At the conclusion of the remarks by Dr. Douglass, the president invited Dr. Stebbins to preside for the remainder of the session during which a number of the scheduled papers were read and discussed. Promptly at noon the session was adjourned and the group moved to the steps of the Geology, Engineering, Metallurgy building for the usual group photograph, which is presented with this report. The picture includes 143 persons, a few less than the total number registered. This was followed by a barbecue lunch served in the patio of Yuma Hall. The weather was delightful and the experience of dining *al fresco* on December 29 was a novel and surprising experience for many who were present.

For the afternoon of this first day a symposium on current problems of Schmidt telescopes was planned. Dr. Whipple presided at this session and Dr. Baade introduced the program. Papers by Dr. Bok and Miss Olmsted of Harvard, by Dr. Terrazas and Dr. Haro of Tonanzintla, Mexico, by Dr. Nassau, of Warner and Swasey Observatory, and by Dr. Baade, of Mount Wilson, were read and discussed. It was a revelation to many to learn of the enormous improvement in astronomical photography effected through the use of the comparatively new device of the Schmidt correcting lens.

The evening of this day was reserved for a reception at the Arizona State Museum, which is located on the campus of the University within a few minutes walk of Yuma Hall. In addition to the very interesting exhibits there relating to the natural history of this region, there was a special exhibit of stellar photographs made by Schmidt telescopes at Harvard and at Mount Wilson. The room in which this exhibit was placed was filled throughout the evening. Tasty and attractive refreshments added greatly to the enjoyment of the evening.

On Friday morning, again strictly on schedule, the reading and discussion of papers was resumed, Dr. Kuiper presiding. The concluding paper of the morning session was the address of the retiring president, Dr. Otto Struve. In the absence of Dr. Struve, the address was read in part by the secretary of the Society, Dr. C. M .Huffer, and in part by Dr. Thornton Page, of the Yerkes Observatory. After the reading of the address, Dr. Joy commented upon the regret he felt in the inability of Dr. Struve to be present at the meeting, upon the eminently successful triennium during which Dr. Struve was president of the Society, and upon the stupendous amount of work accomplished by him. This sentiment was heartily assented to by all present. For the benefit of those who did not hear the reading of the paper as well as for those who will wish to study it more closely, the address is published in its entirety immediately following this report.

The session was then adjourned for the luncheon period. Dr. Greenstein, as presiding officer, called the session to order again at two o'clock, and introduced the symposium on some problems of the dwarf stars. During the afternoon papers by Dr. Joy, Dr. R. E. Wilson, Dr. Weaver, Dr. Kron, Dr. Luyten, and Dr. Kuiper were read and discussed.

The evening of this day was reserved for the Society dinner. Accordingly just before seven, a fairly steady procession of cars was moving in the direction of Hotel El Conquistador, a short distance east of the city. The large dining room of this hotel was practically filled with astronomers and their guests. An elegant and sumptuous dinner was served and enjoyed. Dr. Joy presided and after the dinner he introduced the eight representatives of Mexican observatories, who were in attendance, and the president-emeritus of the University, Dr. Alfred Atkinson, and Mrs. Atkinson. He then called upon Dr. J. J. Nassau, Chairman of the U.S.A. National Committee of the International Astronomical Union, who made the following significant announcement.

"The Executive Council of the International Astronomical Union has recently decided to hold the next general assembly in Leningrad. The exact date of the meeting has not yet been determined, but it will probably take place in August, 1951. At the Zürich meeting the Council had two invitations: one from the Soviet Union, the other from the United States. The American National Committee, acting through its chairman suggested that its invitation be withdrawn. The principal reason for this action was the desire of the American Committee not to compete with the Soviet Union for the place of the meeting. A secondary, but important reason, was the difficulty of finding dollar exchanges for European delegates coming to America. The third and by no means negligible consideration was the experience of some scientific institutions in America who had been unable to secure admission to the United States of distinguished foreign scientists who were suspected of communistic leanings.

"Accordingly the Executive Council of the I.A.U. was actually confronted with a single invitation—that of the Soviet Union. At the request of the former president of the Union, Sir Harold Spencer Jones, Professor A. A. Mikhailov of the Astronomical Soviet of the Academy of Sciences of the U.S.S.R. was requested to give assurance that all participating organizations would be invited to the Leningrad meeting. Such an assurance reached President Lindblad in June of this year.

"The Executive Committee of the U.S.A. Section of the I.A.U. at the present time consists of J. J. Nassau, Chairman; O. Struve, ex-officio member of the Committee as the American Vice-president of the Union; A. H. Joy, ex-officio member of the Committee as President of the American Astronomical Society; C. M. Huffer, ex-officio member of the committee as Secretary of the American Astronomical Society;

Ira S. Bowen, elected by the A.A.S. as its delegate on the National Research Council; and Harlow Shapley elected by the A.A.S. as member of the Committee. American chairmen and secretaries of the committees of the Union are requested to prepare plans for the 1951 meeting. Mr. Nassau will undertake steps to secure information from the U. S. State Department as to the manner in which trips to Russia can be arranged and passports secured. Mr. Nassau will also be glad to receive suggestions with regard to such questions as transportation, time schedules, etc.

"Prospective delegates should communicate with Mr. Nassau who will keep a list of persons planning to go to the meeting and inform them regarding the details of the plan. It is expected that the American Section of the I.A.U. consisting of all the members of the I.A.U. residing in the United States will meet at the time of the summer meeting of the A.A.S. in Bloomington, Indiana. It will be appropriate for members to write to Mr. Nassau making special recommendations for the agenda of this meeting."

Dr. Thornton Page then requested permission to offer a resolution to be acted upon by the assembly. The tenor and style of the resolution attest so clearly the spirit of good fellowship which pervaded the entire meeting that we asked Dr. Page's permission to print it verbatim. The resolution follows.

"I have a motion to put before the house, a motion that concerns the present well-being of us all. Now I realize, Mr. President, that the Constitution and By-laws of this august body require notification of the full membership in advance of presenting motions as important as this one, and, moreover, that the tenor of this house is one of caution. We are not given to passing legislation—or admitting evidence—without careful scrutiny, not only of both sides of the question, but also all round the edges and along all tangents. This literally infinite scrutiny often causes considerable loss of time, but, with your permission, Mr. President, I will, in the accepted manner of scientific dialectic, proceed to speak against the opposition of my motion before making it.

"Now I know that the honorable gentlemen from California not only prefer linear sequences in all things, be they red dwarfs or cafeterias, they also like to consider their state, like their telescopes, the largest and fairest of them all—but I think they may allow a certain uniqueness of the fine desert views, the nitrous-oxide layer in the atmosphere and the clear blue skies (with 6-color transparency almost as perfect as Dr. Stebbins reports in connection with his reddened stars)—these unique features of our present meeting place I am sure they find moderately attractive, even if they do feel unprotected without their smog and fog banks.

"Then there is the eastern block, those rugged individuals, suffering from attacks of conscience for sneaking to these warmer climes for a vacation from their ice bound ridges, at a time of year they selfcon-

sciously call "the most beautiful season in old New England." One of them even seems to have brought his snow banks along in the hypothetical form of comets! However, if I have not lost my political sense, this group is only worried lest the Council may suffer another phase shift and schedule our future meetings south in summer and north in winter; hence I expect their "warm" support.

"Even on the matter of housing, where our hosts have been especially generous—(in fact, the two buildings we have used seem to be so new and so well appointed, that there have been doubts as to how some of the fancy gadgets work)—even on this matter I expect opposition, this time from the younger and more irresponsible of the masculine contingent who felt that the dormitory would have had further attractions if not entirely evacuated by its normal occupants!

"The ladies have probably taken umbrage at too much tempting food. Their husbands may have been worried, as I have, by the nearby shops and Mexican markets where so much money is to be "saved" by the spending of it! These same husbands may be concerned to hear that their ladies were given a lesson in Indian methods of ditching husbands and a brief view of Eddie Cantor's home this afternoon.

"Even with all this opposition, Mr. President, and recognizing the wide differences among us—the easterners and westerners, the conservatives and radicals, the theorists and observers, the believers in photoelectric cells and in photographic emulsions, the wets and the drys, the spectroscopists and astrometrists, those who see canals on Mars and those who don't, the ladies, gentlemen, and big telescope men—I ask for a unanimous and rising vote on the following resolution:

"*Whereas,* we were given warm welcome by the University of Arizona represented by Dr. Nugent,

"*Whereas,* we have spent three or more enjoyable days on the sunny side of the Catalina Mountains.

"*Whereas,* the young ladies of Yuma Hall have put themselves out for our convenience, and

"*Whereas,* the Chamber of Commerce and a number of firms of Tucson have made possible a tasty barbecue, given us every help toward finding the interesting sights in this area and supplied us with mementos of the copper state.

"*Be it resolved,* that we extend our warmest thanks to those our hosts and especially to Dr. E. F. Carpenter and his staff who arranged so happy a meeting for us here."

Dr. Joy then introduced Mr. and Mrs. Robert C. Nichols, of Tucson, who showed a most unusual and most beautiful reel of moving pictures. The pictures were taken of the recently formed volcano, Paracutin, near Uruapan, Mexico, while it was in rather violent eruption. The exposures were made from a heliocopter which hovered near enough to enable the securing of pictures showing the motion in the masses of lava as they were ejected and the motion in the lava stream down the

side of the cone which has been formed. The pictures included scenes depicting the customs and activities of the Indian population in that region, two of whose villages had to be abandoned and later were completely destroyed by the lava flow and the shower of ashes. The comments by Mr. Nichols added very much to the impressiveness of the pictures, since he was able to interpret and give meaning to them. The viewing of the pictures was doubly enjoyable to the writer because, just ten days before, he had had the unusual opportunity of spending a night in the cabin erected, as near to the volcano as was considered safe, by the American Geological Society for the benefit of members of that society who are engaged in scientific studies there. While the writer was there the volcano was very active and the pictures recorded phenomena some of which were almost exact reproductions of what he had witnessed.

At the conclusion of the pictures the meeting was formally adjourned, but many minutes were spent in the hotel parlors in conversation and sometimes in technical discussions.

In order to insure sufficient time for the remaining papers, the final session was called to order by Dr. Whipple even a few minutes before the scheduled hour on Saturday morning. Later Dr. Whipple invited Dr. Kron to preside during the reading of the remaining papers. The last paper was finished almost exactly at twelve o'clock. Dr. Joy then resumed the chairmanship and after a few appropriately chosen remarks declared the eighty-second meeting closed.

After lunch there was much bustle and activity in the corridors of Yuma Hall. Farewell greetings were said as some parties set out for Nogales, some for Mission San Xavier, some for Sahauro National Monument, and some, possibly most, for home. Although there was variety in some repects, there was unanimity in the thought that the meeting had been one of the most successful and the stay in Tucson, one of the most pleasant.

The ladies who had come as companions and not as astronomers, for whom the reading of papers held no special interest, nevertheless found other events very much to their liking. They brought glowing reports and spoke most enthusiastically of the two events scheduled particularly for them, namely, the tea at the home of Mrs. McCormick, the wife of the President of the University on Thursday, and the luncheon at the Triple H Ranch on Friday. A very enjoyable feature of the latter was the lecture in costume by Professor Clara Lee Tanner, of the Department of Anthropology, on the subject "Jewelry of the Southwest."

Although no formal business was transacted at this meeting, the Council received and acted favorably upon twenty-seven applications for membership in the Society. The names of the persons elected to membership follow.

Baglow, Robert L., Richmond Hill, Ontario
Cox, Arthur Nelson, Bloomington, Indiana
Davis, Professor Leverett, Jr., California Institute of Technology

Donselman, Robert W., University of Michigan
Edmonds, Frank N., Jr., Yerkes Observatory
Harrington, Francis D., United States Naval Observatory
Harrington, Robert G., California Institute of Technology
Huschen, David Sutphin, University of Illinois
Horak, Henry G., Yerkes Observatory
Ice, Herschel C., Reading, Pa.
La Fara, Robert L., Indiana University
Lewis, Edward M., University of Michigan
McCrosky, Richard E., Meteor Observing Station, New Mexico
Meinel, Aden Baker, Lick Observatory
Mooshy, Carolyn L., University of Michigan
Nelson, Burt, Washburn Observatory
Owren, Leif, University of Oslo
Rudin, Bernard D., California Institute of Technology
Rule, Bruce H., California Institute of Technology
Rush, Joseph H., Boulder, Colorado
Scott, Miss Elizabeth L., University of California, Berkeley
von Weizsäcker, C. F., University of Chicago
Weber, Miss Nancy E., Haverford, Pa.
Weston, Edwin B., University of Michigan
Whitt, Samuel S., Arlington, Va.
Wyller, Arne A., Harvard College Observatory
Yoss, Kenneth M., University of Michigan

Spectroscopic Binaries*

By OTTO STRUVE

It is the duty of the retiring president "to deliver an address before the Society at the meeting next after that in which his term of office expires." I regret that it is not possible for me to be in Tucson today, but I shall carry out this assignment by asking the secretary to read this paper for me.

The American Astronomical Society has increased greatly in stature and in membership since its beginning in 1897. It was the intention of our founders to create a strong scientific organization with a purpose which they defined in the broadest possible terms as "the advancement of astronomy and closely related branches of science." They adopted a high standard for the election of members: the requirement that candidates be "deemed capable of preparing an acceptable paper upon some subject of astronomy."

We now face problems which were unknown to our predecessors; to cope with them we shall need to draw upon the combined wisdom, experience, and good will of all the members of our Society. With this in mind, I want to mention some thoughts I have had since we met in Ottawa last summer.

The three years of my presidency have been a period of post-war reconstruction in astronomy and of a re-appraisal of our efforts. As physical scientists we are affected by the soul-searching doubts of the

*Address of the Retiring President of the American Astronomical Society, read at the Tucson meeting in December, 1949.

atomic scientists, and as the representatives of the most international among the sciences we are disturbed by the growth of narrow nationalism in science. Political considerations unknown to our founders and abhorred by our immediate predecessors have been thrust upon us by those who wish to make of science a tool for advancing their own ideologies. Some of the developments represent real dangers, and I should like to direct the attention of the Society and of our new president to three dangerous issues.

The first danger comes from without. Recently, attacks made upon us by astronomers of the Soviet Union, combined with boastful assurances of their own pre-eminence, have filled many of our members with deep concern. We are portrayed as ruthless stooges of a capitalistic conspiracy to enslave the world, who deal out incorrect scientific information in order "to prove the futility of life on earth and to disarm the will of the people to change the existing order." We are accused of medieval faith and an "idealistic" outlook by those who profess to serve only the dictates of pure materialism.

The second danger comes from within. It is disheartening that a famous foreign astronomer who was invited to work at an American observatory was refused a visa by our State Department without any explanation of this action to the institution that invited him. By acts of this nature, the interests of science are defeated, American prestige is lowered, a potential friend of our democracy may very well have been turned into an enemy, and a suspicion is created that political attempts to control scientific thought are not all confined to countries on the other side of the Atlantic.

The third danger lies within ourselves. It is all too easy, step by step, to relinquish our freedom of scientific inquiry and to surrender to political powers our right to control our thought. Fear of political persecution and of social ostracism are cropping up in unexpected places. We must remain united as never before; we must not allow our differences to blind us to the dangers I have referred to. The Council may wish to form a committee to draft a declaration which will embrace our views on the freedom of our science, its purpose, and its method. I believe that such a statement would dispel the confusion that exists in the minds of those who misunderstand or misinterpret us.

For the scientific part of this paper I have chosen the subject of spectroscopic binaries. Two months ago, on the occasion of the George Darwin Lecture in London, I made a survey of this field. Today I shall discuss only a few details which I hope will be of interest.

The first three spectroscopic binaries were discovered sixty years ago. E. C. Pickering announced the periodic doubling of the lines of Zeta Ursae Majoris (Mizar) on Harvard objective-prism plates. H. C. Vogel, at Potsdam, followed with the discovery of the variable radial velocity of Beta Persei (Algol), and Miss A. C. Maury, at Harvard, found double lines in Beta Aurigae.

PLATE II

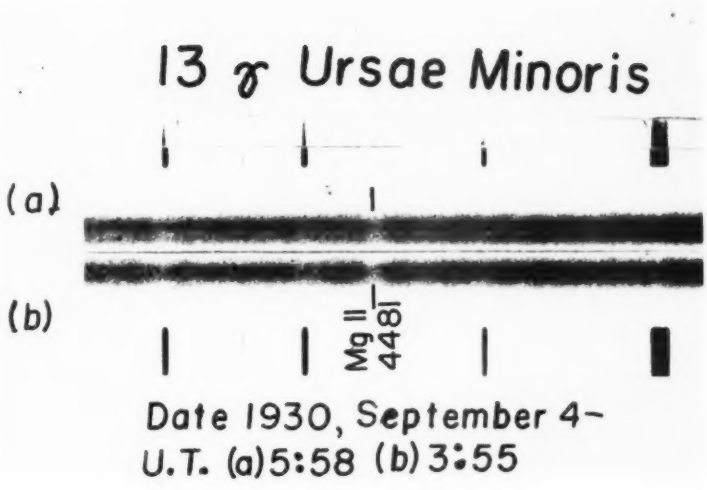

FIGURE 1

Spectrum of Gamma Ursae Minoris showing shift in the line Mg II 4481. (Note that stellar line in upper spectrogram is displaced toward the right.)

FIGURE 2

Unsymmetrical absorption lines of hydrogen in U Sagittae.

By 1905, several observatories were taking an active interest in the discovery of new spectroscopic binaries and in the determination of their orbits. The Lick Observatory, under W. W. Campbell, was far in the lead with 72 discoveries, and the Yerkes Observatory, under E. B. Frost and W. S. Adams, came second with 41. *Lick Observatory Bulletin* No. 79, by Campbell and Curtis, presented the first general catalogue of these objects, listing 140 binaries of which fewer than 20 had reliable orbits. The methods of computing these orbits had already been developed by Lehmann-Filhés, Wilsing, and Schwarzschild in Germany, Russell and Laves in the United States, Nijland in the Netherlands, etc., and these methods were further elaborated by Schlesinger, King, Henroteau, Pogo, Zurhellen, and others.

The next period in the study of spectroscopic binaries witnessed a rapid increase in the number of discoveries, as well as in orbits. In 1910 Campbell published his second catalogue. The total number of stars with variable radial velocities rose to 306, and the number of orbits to more than 70. The material was sufficient to invite critical discussion, and in the same year—1910—there appeared three fundamental papers on the distribution of the various properties of spectroscopic binaries, by Campbell in the *Lick Observatory Bulletins*, by Schlesinger and Baker in the *Publications of the Allegheny Observatory*, and by H. Ludendorff in the *Astronomische Nachrichten*. These, and other, investigations furnished a pattern of research which culminated in the determination of the masses of the hotter stars for which there is no reliable information from the orbits of visual binaries.

In the meantime the observational work continued unabated. Several new catalogues were issued; by H. Ludendorff in the *Vierteljahrsschrift der Astronomischen Gesellschaft*, and by Campbell, Moore, and Neubauer in the *Bulletins of the Lick Observatory*. The last of these, issued in 1948, contains more than 500 orbits, including some systems for which the observations are of low accuracy, but excluding all those stars of variable radial velocity which Moore did not regard as true binaries, namely, Cepheid variables, β Cephei stars, and stars having peculiar shell-type spectra.

This catalogue no longer lists the discoveries of new variable radial velocities. In 1936 Moore had estimated that there were about 1420 objects of this kind. At about the same time (1932) his "General Catalogue of the Radial Velocities of Stars" listed a total of 6739—including the binaries. But Moore refrained from drawing the conclusion that about one star out of every five is a spectroscopic binary. Such a conclusion would have been of little use, first, because many of the stars announced as binaries are not really binaries, but have such diffuse lines that the errors of measurement are large; and second, because the frequency of binaries is related to the physical characteristics of the stars: their masses, radii, and luminosities; their rotational velocities, etc. But the question is cosmogonically important: if close spectro-

scopic binaries form a large fraction of all stars, then we must consider binary formation and evolution as an important process in the galaxy, perhaps even as a process which in one form or another affects the history of every normal star.

For the cool dwarfs the frequency of all types of binaries may be estimated by considering a more-or-less complete sample of stars in the solar neighborhood. This was done by G. P. Kuiper, who found that about 68 per cent of stars having masses greater than the sun are known to have divided into one or more parts. For the less massive stars the fraction of binaries is smaller. Kuiper also attempted to find, by means of what he described as a "conjectural" statistical discussion, the frequency of companions to stars of very early spectral class. The result is "200 per cent, or 2 companions per star . . . a not unreasonable value."

My own work on spectroscopic binaries started a little more than a quarter of a century ago, and my first paper on this subject was presented to our society at the 1922 meeting in Williams Bay. I was concerned with some strange variations in the radial velocity of the A-type star Gamma Ursae Minoris, which seemed to occur at very short intervals of time, and led to the announcement of a tentative period of 2½ hours, with a velocity range of about 30 km/sec. But the results were highly unsatisfactory and for many years thereafter I avoided Gamma Ursae Minoris and other, similar stars, as though they were the plague. My work had been inspired by E. B. Frost's discovery of a 4½-hour variation in the radial velocity of β Cephei and the determination by J. Paraskevopoulos of a 3½-hour period for Tau Cygni. I also knew that astronomers at the Lick Observatory had found a 6-hour period for β Canis Majoris and for 12 Lacertae. It seemed reasonable to suppose that similar short-period variations would be found in other stars.

But the evidence was disappointing. The spectral lines of Gamma Ursae Minoris are exceedingly diffuse and weak: it is a typical A star with large rotational broadening. The same is true of several other stars which I investigated at the same time (Gamma Lyrae, 57 Ursae Majoris, Delta Aquilae). The errors of measurement were large, and the velocity curves from night to night showed large changes. A recent inspection of the old spectrograms convinces me that the variations in the positions of the lines are real. Figure 1 shows two spectrograms of Gamma Ursae Minoris taken on Process emulsion. The interval between them is $3^h\,37^m$ or 1.4 P. On the earlier plate Mg II 4481 is shifted to the violet by a greater amount than on the later plate. But the velocity-curves on different dates are not the same: there are large changes in the amplitude and shape of the curve; and there are occasionally long interruptions with no perceptible variation in velocity. When the velocity does change, there is an apparent periodicity with P = 2½ hours. Simi-

lar results have been obtained for several other stars, and apparently their light curves are also subject to large, irregular variations.

It is probable that there are three distinct groups of these objects. In several supergiants there are small, irregular fluctuations in the radial velocity which, according to G. F. Paddock, in the case of α Cygni, occur in cycles of 8 to 16 days, but which in some shell-type objects require only a few hours. It is perhaps reasonable to attribute these fluctuations to the large-grain structure of the atmospheric turbulence. In main-sequence stars with large rotational line-broadening we sometimes observe peculiar deformations of the contours, such as an apparent doubling in α Virginis. It is possible that unsymmetrical surface markings, such as large spot-areas, may produce apparent shifts in the lines. These features rotate with the star, and during their lifetimes the period would always be that of the axial rotation. Different spots would give rise to changes in the epoch. There would be oscillations in the brightness of such a star—P. Guthnick and R. H. Baker observed them in Gamma Ursae Minoris—but they would be subject to the same inconsistencies as the radial velocities: the epochs would undergo sudden changes and the amplitude might be variable. There could be intervals of time when light and velocity are constant. Periods of rotation of the order of 2.5 to 6 hours are not improbable. There should be a correlation between P and line-width, but because of the random distribution of the inclinations this correlation might not become apparent at once.

The proposed mechanism accounts for the erratic behavior of Gamma Ursae Minoris and of some other stars of this group, but it does not account for the B-type stars β Cephei, 12 Lacertae, σ Scorpii, and β Canis Majoris, all of which have fairly narrow lines, so that rotation cannot be an important factor. These stars have constant, or nearly constant, periods, without sudden changes of epoch.

For many years we have believed that the β Cephei stars are somehow related to the Cepheids. But they really do not fit into the general sequence of the Cepheids and RR Lyrae variables. The latter, with periods similar to those of the β Cephei stars, have (a) large amplitudes in brightness, (b) the usual characteristic "mirror-reflection" relation between velocity curves and light curves, and (c) spectral types not earlier than A0. It is true that there are a few strange variables, like AI Velorum, in which the period is constant but the amplitudes of light and velocity undergo large, irregular changes, but the β Cephei stars bear no resemblance to these peculiar variables.

Perhaps we should take notice of the remarkable spectroscopic difference between β Cephei and β Canis Majoris. The former is a main-sequence object, the latter a moderately luminous supergiant. Yet, the periods differ only slightly. This constitutes a serious difficulty which we have not yet overcome. It may even become necessary to review once more the possibility that these stars are real binaries. The small

value of $a \sin i \sim 50{,}000$ km has usually been considered a sufficient argument against this idea. But if the companion is a very small, dense star—not necessarily a white dwarf, but a sufficiently small object to resist disruption in the immediate vicinity of the surface of the primary—then we can estimate that the mass-ratio is $m_1/m_2 \sim 100$ and $a_2 \sin i = 5 \times 10^6$ km $\sim R_*$. A very small, planet-like object might revolve around the B-type primary in a period of about 5 or 6 hours and produce the observed shifts in the radial velocity. The peculiar double period of β Canis Majoris investigated by Meyer, might be explained by two planet-like companions. But the light curve does not resemble that of an eclipsing binary: maximum brightness occurs approximately at phase 0.125 P after "mid-eclipse," and the shape of the curve is approximately symmetrical. We must therefore leave the question open. Luyten's discovery, among the visual binaries, of several systems in which one component is a white dwarf, and of one system in which both components are such objects, has brought to the forefront the question of peculiar spectroscopic binaries of the kind we have just discussed. Previously it was believed that mechanical instability limited the separation between the components of a binary to a value slightly in excess of $R_1 + R_2$ where both R's represent radii of "normal" stars. But if R_2 is very small, the separation may not be much larger than R_1, and the corresponding period may be of the order of 4-6 hours if R_1 refers to a normal B star. Of course, when both components are white dwarfs $R_1 + R_2$ may become very small indeed, and the period would be less than one minute, but the discovery of such a system would probably have to be made by photometric, and not by spectroscopic means.

The large mass ratio, $m_1/m_2 = 100$, is, thus, at present only a product of our imagination. But there is another reason why we must accept as real a large range in the mass ratios. If we consider the statistical distribution of the quantity

$$y = cK_1P^{1/3}(1-e^2)^{1/2} = \sin i \frac{m_1^{1/3}}{\alpha^{1/3}(\alpha+1)^{2/3}} = x \sin i,$$

where $\alpha = m_1/m_2$, we can determine the distribution of x by solving an integral equation similar to that which we have been solving, by graphical means, in the problem of finding the true distribution of stellar rotational velocities. Chandrasekhar and Munch have recently given an analytical method for obtaining the characteristic properties of the true distribution of x when the observed distribution of y is known. But in the present case observational selection must be allowed for because binaries with small range in velocity, K_1, are not easily found. This is best done in the following way: we suppose that the observations are complete for $K_1 \geqslant 75$ km/sec, and that for smaller values the probability of discovering a binary is a linear function of K_1, such that

$$\begin{aligned} p &= K_1/75 && \text{for } K_1 \leqslant 75 \text{ km/sec} \\ p &= 1 && \text{for } K_1 > 75 \text{ km/sec.} \end{aligned}$$

It is relatively easy to correct the observed distribution by multiplying the observed frequencies by 1/p. The result is a curve which rises steeply towards *small* values of K_1. If x were a constant value, the distribution would be given by the function

$$f(x) = \frac{y}{x\sqrt{x^2 - y^2}} \qquad (y \leqslant x = \text{const.})$$

and would have a sharp maximum for *large* values of K_1. Thus, x is not a constant, even when we limit the material to a single spectral class of the primary component. The true distribution of x shows a large dispersion. This may be caused by the dispersion in m_1, or in a, or in both. But a crude method for separating the two consists in adopting the range of m_1 as determined from double-lined spectroscopic binaries of the same spectrum and correcting the distribution of a for that of m_1. For example, we could use a Gaussian distribution with an appropriate dispersion. The result shows a large spread of a. Values of the order of 10 are frequent and values of the order of 100 are quite possible. We cannot be certain of the shape of the frequency curve for large a.

In conclusion I should like to describe a puzzle which has bothered me a good deal in recent months and which I was only able to mention in the Darwin Lecture. You will probably recall that A. H. Joy many years ago found unsymmetrical lines in the eclipsing binary U Cephei. Since then I have observed these lines not only in U Cephei, but also in U Sagittae (Figure 2), RZ Scuti, and a few other eclipsing binaries, while Hiltner and Hardie have seen them in RW Tauri.

In Figure 3 I have tried to sketch in a schematic way the results of these observations. The true velocity curve is a sine curve indicated by the continuous line. In reality, however, we do not observe a symmetrical velocity curve. Instead, the motions follow the curve designated by the letters A′-A″. An examination of the original plates shows that in the vicinity of the point A′ the hydrogen lines are unsymmetrical and the measurements refer to the deepest point of the red-displaced absorption core. Since the asymmetry of the line at different stages is quite conspicuous, we can correct the measures in such a way as to obtain the point B′ which corresponds to the center of the broad Stark effect wings. The corresponding points are shown in the figure by the solid dots. These points give a maximum radial velocity in conformance with the symmetrical sine curve adopted to represent circular motion. I have given elsewhere a large amount of evidence indicating that the narrow cores responsible for the high maximum of the curve at A′ are produced by a stream of gas flowing around the entire system and causing a distortion of the velocity curve.

The puzzle I have referred to arises in the vicinity of the points A″ and B″. At this stage the hydrogen lines are unsymmetrical in the opposite sense: the deepest point of the narrow core, A″, is displaced toward the violet of the center of the wings, at B″. At first I thought

that this effect might be due to the rotational disturbance which sets in at the beginning of the partial eclipse, but it turns out that this phenomenon is present even before any part of the B-type star is covered by the G-type star. I next thought that the cores of the lines fall below the sine curve and that the centers of the hydrogen wings would presumably be in accordance with this sine curve. However, I was very much surprised to find that this is not so: the narrow cores are, if anything, above the sine curve and the centers of the wings must be about 100 km/sec more positive. They follow approximately the trend of solid dots in Figure 3, while the cores follow the trend of the open circles.

It is very remarkable that the shift in the asymmetry of the hydrogen lines occurs so rapidly. At phases near 0.80 P the core is displaced toward the red. At phase 0.875 P the core is already on the violet wing of the hydrogen line.

This is a remarkable result and one which deserves careful study. It is not shown by the other lines, such as helium, magnesium, silicon, etc. Moreover, it must represent a real distortion of the hydrogen lines as produced in the atmosphere of the B-type component, since the pressure in the whirlpool stream is much too low to produce the broad Stark effect wings.

In order to explain it we must note that it is independent of the eclipse, that it affects the broad wings of hydrogen and is therefore somehow related to the Stark effect, and that it appears only in stars having large rotational velocities. Moreover, it seems to be unrelated to the velocity curve as produced by the narrow core. Apparently, we must eliminate from our mind any thought of a connection of the stream (and the absorption core which it produces) and the atmosphere of the B-type star which gives rise to the broad wings. After the eclipse the events are opposite to those observed before eclipse. There is some slight indication that a small amount of asymmetry exists also at phases 0.375 P and 0.625 P.

It seems to me that the explanation may lie in a combination of rotation and Stark effect. If the B star is tidally distorted to form approximately a cigar-shaped body, then at the tips the Stark effect is weak. In Figure 4 I have shown schematically how the hydrogen lines of the B-type star may become unsymmetrical at phase 0.875 P. The rotational velocity of this star in the case of U Cephei is about 200 km/sec. Hence, one limb approaches us with a velocity of 200 km/sec and the other recedes with the same velocity. During the quadratures and conjunctions the spectral lines will be symmetrical (except for the effects of the eclipse and of the stream of gas), but it must be remembered that the pressure in the tidal bulges of the atmosphere is smaller than in other parts of the elongated surface of the star. Hence, the spectral lines contributed by the bulges will be narrower than those produced by the central regions. At phase 0.750 P the bulges produce two symmetrical

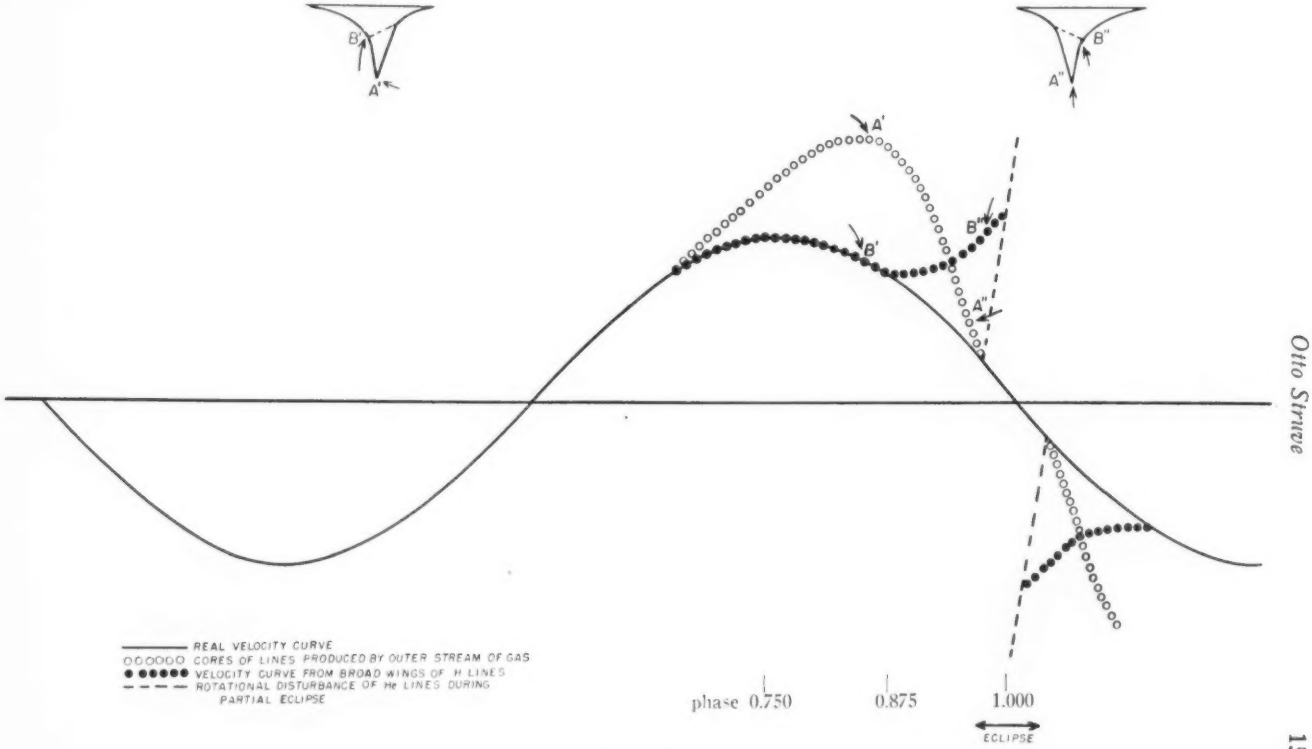

FIGURE 3
Schematic explanation of unsymmetrical lines in U Cephei, U Sagittae and other eclipsing systems.

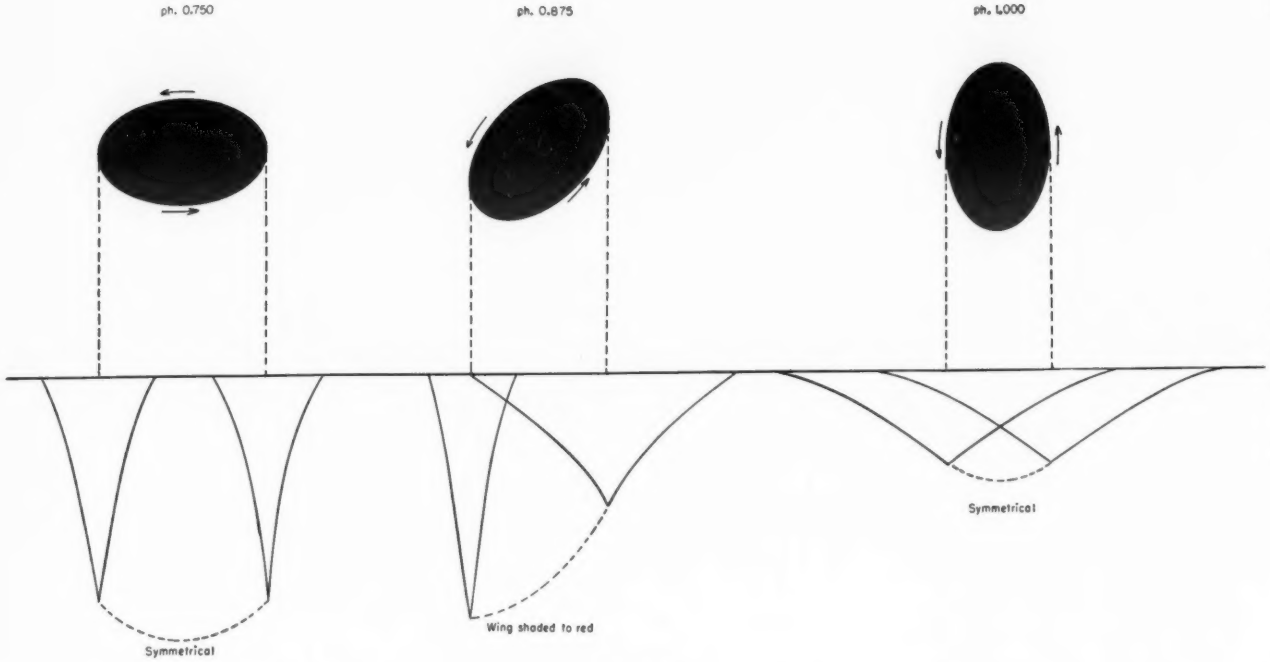

FIGURE 4
Explanation of unsymmetrical hydrogen lines.

components which are schematically indicated at the bottom of the figure. The complete contour must be obtained by integrating the appropriate contour for the entire surface of the disc. At phase 1.000 P the edges of the disc produce broad lines and they are again symmetrically spaced; but at phase 0.875 P the nearer end of the cigar approaches, but since it has a small pressure the line it produces is sharp. The opposite end of the cigar is invisible. Instead, the receding part of the star corresponds to an area of large pressure and the corresponding line will be greatly broadened. The combination of the two lines would give an unsymmetrical contour, with a shift of the order of $V \sim 100$ km/sec, which agrees with the observations. The phenomenon would not be present in lines which are not sensitive to Stark effect. This is also in agreement with the observations. The opposite effect is present at phase 0.125 P. If the B star is symmetrical we should expect a similar distortion at phases 0.375 P and 0.625 P, but it is certain that the two tidal bulges are different in height. This effect is observationally very conspicuous, and it has remained undiscovered this long because it is complicated on the one side by the sharp lines produced in a low-density, stream-like medium and on the other by the geometrical Schlesinger-Rossiter-McLaughlin distortion of the velocity curve. Mr. Robert Hardie is studying this new phenomenon at the present time.

YERKES OBSERVATORY, WILLIAMS BAY, WISCONSIN.

Origin of Carolina Bays*

By WILLIAM F. PROUTY

So much has already been published about the "Carolina Bays" that it is questionable as to whether any further discussion of them is in order at present. Nevertheless, we are printing the following notes, partly because of the unusual circumstances surrounding them. Dr. Prouty corrected the manuscript the day before his death which occurred on June 27, 1949. The manuscript was submitted by his secretary for publication. Since the notes pertain principally to a paper by Mr. Chapman Grant in POPULAR ASTRONOMY, **56**, *p. 511, the notes were read by him. In fairness to all concerned, Mr. Grant's comments are given at the close.* EDITOR.

The article by Mr. Chapman Grant challenges the validity of the modified meteoritic theory of the origin of the Carolina Bays advocated by the writer. Due to the fact that the writer has nearly completed a manuscript with a lengthy discussion of the origin of the Carolina Bays, based upon extensive surveys and field studies since 1933, it was

*A reply to an article by Mr. Chapman Grant, published in POPULAR ASTRONOMY, **56**, p. 511.

thought at first that a reply at this time to the article by Mr. Grant would not be advisable, but when it was learned that publication of such detailed discussion would necessarily be delayed many months it was thought best to make very brief statements concerning the more important objections raised by Mr. Grant to the modified meteoritic theory.

The modified meteoritic theory holds that the Carolina Bays were formed by the infall of a shower of meteorites, hitting the Earth at an acute angle to the horizontal; that the elliptical, rimmed depressions were made chiefly by the compressed air (air shock-waves) accompanying the falling meteorites in the sand-blanketed coastal plain area. According to this theory, the aperture made by the actual contact of meteorite with the Earth is relatively small and usually near the center of the bay.

There are 17 statements made in the lengthy article by Chapman Grant used as arguments against the modified meteoritic theory, which require analysis or correction. These statements, with my comments, follow.

1. Bay rims are better developed along their northeast quadrants.

This statement is at variance with that of all other scientists who have written concerning the bay rims. The southeast quadrant is the one cited as having the best development. In some bays, sand dune areas are well developed on the northeast side of the bays, as a result of the prevailing southwest winds of the region and the local distribution of topography and sandy areas. The unsymmetrical arrangement of the better developed sand rim at southeast end of the bay is apparently due to the shifting of the originally bilaterally symmetrical rim at the southeast end of bay a little more to the east or northeast by wind action.

2. A large meteorite should explode on hitting the Earth and therefore should give a circular rather than elliptical crater.

According to the Air Shock-Wave Meteoritic Theory, the bay rims are formed by the air shock-waves accompanying the falling meteorite and should be elliptical for meteorite approaching Earth at an acute angle irrespective of the explosion of the meteorite mass or several meteorite masses falling within the area of the elliptical sand rim. It is not probable even that the depression made by the meteorite itself would be entirely circular. Where it hit the loose, moist, and easily penetrated Coastal Plain material, the "explosion" could better be explained as a rapid evolution of gas as the meteorite penetrated the Earth.

3. No meteoritic material has been found in the Coastal Plain.

One should not expect to find any unweathered meteoritic material near the surface of the loose textured, wet, and pervious Coastal Plain after an interval of several thousand years, but one would expect to find meteorites preserved in the deep impervious, clay soils of the Pied-

mont to the northwest of the Coastal Plain where a map of meteorite finds shows them to be present in unusual numbers.

4. There are no elliptical meteorite craters on Moon.

This is, of course, no argument against the air shock-wave meteoritic theory on the air blanketed Earth. The statement "that there are no elliptical craters on the Moon" seems to be a bit overdrawn as some of the lunar craters which have a relatively smooth surface (that is, are without the central spur) seem to have bilateral symmetry and are therefore slightly elliptical. Such craters can be seen very close to circular craters with central spurs. If both types of craters were made by meteorites, would it not be logical to think of the circular craters with central spur as the result of nearly vertical infall and the smooth surfaced and slightly elliptical type as due to a more acute angle of infall, similar to the acute infall at Meteor Crater, Arizona, where air shock-waves would have little effect on the hard rock surface of the Kaibab Plateau, or the one recently reported from Australia.

5. The long axes of the bays should be parallel, but they are not.

The modified meteoritic theory explains the regional shift in bay orientation as the result of the spreading (fanning out effect) of a flock of meteorites in its passage through the atmosphere, and the local variations as due to mild explosions of the meteorite in passage through the air or to tandem meteorites as affected by the air compression cone.

6. Small bays should be more circular than large bays, but they are not always so.

The recorded ellipticity of 130 bays shows that the smaller bays are in general less elliptical. It also shows that the smaller bays have much greater variation in ellipticity as should be expected from the fragmentation of some meteorites in their passage through the atmosphere. Some fragments are thrown at greater angle to the Earth and others at less angle.

7. Multiple sand rims represent several hits in the same crater, but their frequency—some with six hits—make the theory untenable.

There is no apparent limit to the number of overlapping bays that may occur in one group according to the meteoritic theory. One multiple bay is known to have twelve separate overlapping units and another one close-by has eight.

8. Sand rims are made of pure white sand and are not like the general formation of the surrounding area.

Pure white sands are to be expected in any sand deposit in a humid climate where the sand rises above ground-water level and has organic matter draining constantly through it. By such process any clay or iron stain is removed and carried to a lower level.

9. The rims are so large that any meteorite making them must have exploded.

The rims, according to the modified meteoritic theory, are not made by the explosion of the meteorite but by the air shock-waves accompanying the fall of the meteorite. This should be many times larger than the "explosion crater" made by the contact of the meteorite with the Earth.

10. No rim contains more than 1/25 the volume of the crater.

This statement does not seem to be true in most cases if the volume of the crater is measured from the general ground level. According to any theory of origin the finer and more soluble particles would be carried away and would not be found in the rim. In the modified meteoritic theory, the sand rim would be chiefly made up of the coarser sand particles.

11. Where rims intersect they should be larger.

This is not necessarily so. In some cases the rims at intersection point are not increased in size but in many cases the size is increased at such intersection. This fact seems to be governed by the local conditions. The same result should be had from shoals of fish theory as from modified meteoritic theory.

12. Bays do not occur in hit or miss manner but are correlated with beach ridges, drainage systems, and elevations. Therefore, meteoritic theory should be laid permanently to rest.

An analysis of the above statement disproves the conclusion reached. The larger bays in places cut across several parallel beach ridges and swales. In fact, bays occur at all levels in the Coastal Plain area and the same bay cuts across different levels, as well as different formations. There does not seem to be any correlation with elevation or formations.

13. No streams run into bays.

The number of bays which have streams running into them is comparatively small, but there are several. Some have streams running completely through them. In most cases the formation of the bay rims has deflected the course of streams around the bay.

14. Ovoid shape of bay cannot be attributed to any component of the Earth's movement because both ovoid and elliptical bays occur in the same region.

Probably most ovoid bays are due to tandem meteorites as affected by the eastward turning Earth and its atmosphere. A considerable number of multiple bays are seemingly formed by tandem meteorites.

15. It is impossible to account for small bays within larger ones by "air blast theory."

The meteoritic theory in either the modified or unmodified form most readily explains such occurrence. It is very difficult, however, for most other theories to explain it.

16. The width of the zone of bay occurrence from Atlantic to the Piedmont is only about 40 miles, too narrow a strip to be explained by meteoritic theory.

Bays occur on practically the entire width of the Coastal Plain from coast to Piedmont, which is more than three times the width stated. There is indirect evidence that bays were formed also in the Piedmont, but erosion has destroyed them and has exposed an unusual number of meteorites, better preserved in the clay soil of the Piedmont.

17. There is no instance of a bay interrupting the ridges (beach ridges).

There are thousands of examples of such interruption shown in the aerial photographs.

JUNE 26, 1949.

COMMENTS BY MR. CHAPMAN GRANT

I have met Dr. W. F. Prouty and remember him as a sincere and amiable gentleman. It is therefore with regret that I take up a subject in which we differed. Unfortunately the brilliant story by Herbert Ravenel Sass which appeared in two magazines of national circulation has fixed in the mind of the impressionable public an exciting catastrophe vividly portrayed, without any scientific knowledge of the facts.

Dr. Prouty has answered my disproofs of the possibility of a meteoritic origin of the Bays paragraph by paragraph. I shall not take these up in detail, but shall ask the interested reader first to study my article in the December, 1948, issue of this Journal. My paper was written with great care after personal observation on the ground and from the air and after minute study of a large number of fine aerial photographs. I adhere, to the letter, to my findings as stated in my 1948 paper.

I wish to thank Dr. Gingrich for the opportunity of replying to Dr. Prouty's statements, which, under happier circumstances, I would have done in detail.

May I take this opportunity to invite the interested readers' attention to my biological hypothesis of the origin of the Bays which appeared in the *Scientific Monthly* of December, 1945, pp. 443-450. To date the only answers to this hypothesis have been the rather flattering ridicule such as that which met the first proponents of the "theory" of glaciation. On the other hand many scholars have written me that they agreed with it. Correspondence is invited, and should be addressed to Mr. Chapman Grant, 2970 Sixth Avenue, San Diego 3, California.

Planetary Phenomena in 1950

By PAUL S. WATSON

GRAPHIC TIME TABLE OF THE HEAVENS

This is a condensed and simple almanac in graphic form published annually by the Maryland Academy of Sciences, Baltimore. It gives the rising and setting times of the Sun, Moon, and brighter planets, the beginning of morning twilight and the ending of evening twilight, the times when the visible planets and certain

other objects of particular interest cross the meridian, occultations of bright objects by the Moon, and other useful astronomical information.

It is computed for 40° north latitude and 90° west longitude (6 hours west of Greenwich), and is therefore correct for only this point on the Earth, but it can be used to advantage anywhere in the United States, provided the user, wherever he is, make correction for the distance he may be from his own particular time meridian. The corrections for a number of important cities are listed below:

Atlanta	+38 min.	Memphis	0 min.
Baltimore	+ 6 min.	Milwaukee	— 8 min.
Birmingham	—13 min.	Minneapolis	+13 min.
Boston	—16 min.	New Orleans	0 min.
Buffalo	+15 min.	New York	— 4 min.
Chicago	—10 min.	Oklahoma City	+32 min.
Cincinnati	+38 min.	Philadelphia	+ 1 min.
Cleveland	+27 min.	Pittsburgh	+20 min.
Denver	0 min.	Rochester	+10 min.
Detroit	+32 min.	Salt Lake City	+28 min.
Helena	+28 min.	San Francisco	+10 min.
Houston	+22 min.	Santa Fe	+ 4 min.
Indianapolis	—16 min.	Seattle	+10 min.
Kansas City	+18 min.	St. Louis	+ 1 min.
Los Angeles	— 7 min.	Washington	+ 8 min.

(Note: Places for which the correction is minus are east of the standard time meridian, and therefore all events, with the exception of eclipses and occultations, will be earlier by the amount stated. All places with plus correction are west and therefore these events occur later.

For most events, such as the rising and setting of the planets, it makes practically no difference what standard time meridian in the United States is used. For moonrise and moonset, however, the times shown are correct for the 90th meridian. For the 75th, 2 minutes should be subtracted, while for the 105th and 120th, 2 and 4 minutes, respectively, should be added on the average. Certain events, such as eclipses of the Moon and the phenomena of Jupiter's satellites, occur at a specified time regardless of location. In these cases the time is given in Eastern Standard Time and the appropriate correction should be applied for other time belts. For occultations the time given is for Washington, D. C. For other locations consult the *American Ephemeris and Nautical Almanac*.

Correction for difference in latitude is comparatively minor and may in general be neglected.

Separate copies of the Time Table, as here reproduced, may be obtained without charge from the Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral Street, Baltimore 1, Maryland. Blueprints of the original drawing before reproduction, 40 by 27 inches, may be obtained at cost—75c each. A Quebec edition, in French, computed for 47° north latitude and 75° west longitude, is also available without charge.)

Across the top of the Time Table are shown the hours of the night from 4 P.M. to 8 A.M. the next morning. Down the sides is indicated the date, each horizontal line representing a Thursday evening. The dashes on the sunset and sunrise curves aid interpolation on intermediate days. The various lines indicate the rising, setting, and transit times of the heavenly bodies.

The phases of the Moon are indicated by the conventional symbols. Thus, the Moon is new within 12 hours of 8 P.M., C.S.T., on January 17 and sets at 4:12 P.M. (even though invisible). First quarter is shown on the night of January 25-26, when the Moon sets at 12:50 A.M. Full Moon takes place on February 2

and it will rise at 5:10 P.M., and last quarter occurs on the night of February 9-10, when the Moon will rise at 1:48 A.M. The small black circles show moonset for the first half of the lunar month and the small open circles indicate moonrise for the second half of the lunar month. Obviously, the various phases of the Moon cannot be indicated closer than 12 hours. Small squares on planet curves indicate quadrature and half-circles greatest elongation. The "rose" on the rising curve for Venus indicates when that planet is at greatest brilliancy. Opposition of a planet is shown by the conventional symbol of two joined symbols. Roman numerals give Sidereal Time at midnight. The curve along the midnight line indicates the Equation of Time (this is the difference between mean or clock time and apparent or Sun Time). When the curve is left of the midnight line, the Sun is fast and arrives at the meridian before 12 o'clock noon, Local Time, by the amount indicated. When the curve is right, the Sun is slow. The small numbers on the left hand side of the Time Table indicate the Julian Day number, of interest to variable star observers. Thus, the Julian Day, beginning Greenwich Noon, January 1 is 2,433,000 plus 283, or 2,433,283. The diagonal lines extending to the midnight line, marked Pleiades, Great Nebula in Orion, Castor, etc., indicate when these objects transit or cross the meridian, that imaginary line running north and south which divides the sky into its eastern and western halves. Other information of the Time Table is self-explanatory.

Now, the events of the night of January 5-6, can be easily found by following the horizontal line for that date across the page from left to right: The Julian Day number is 2,433,287; the Sun sets at 4:48 P.M.; the Moon rises at 6:14 P.M.; Mercury sets at 6:15; evening twilight ends at 6:26; Jupiter sets at 6:36; Venus sets at 7:36; the Pleiades transit or cross the Meridian at 8:44; Saturn rises at 10:00; the Great Nebula in Orion transits at 10:36; Mars rises at 11:12; the curve for the Equation of Time indicates that the Sun is slow and will not arrive at the meridian until 6 minutes after 12 o'clock noon, Local Time; Saturn transits at 4:22 A.M.; Mars transits at 5:16 A.M.; morning twilight begins at 5:45; and the Sun rises at 7:22 A.M.

The Planets for 1950

Based on the Graphic Time Table of the Heavens, a summary of the interesting planetary events for the year 1950 is given below. For more detailed information reference should be made to the *American Ephemeris and Nautical Almanac*, the principal source used in the calculation of the Time Table.

Mercury: The elusive planet Mercury will make six brief appearances during the year, three times as an evening star and three times as a morning star. The most favorable elongation for the year will occur on April 22, when the planet will set 1 hour and 47 minutes after the Sun, some 10 minutes after the end of evening twilight. Other evening elongations are August 21 and December 15, but these will not be as favorable. Morning elongations will be February 10, June 9, and October 3, this last one being the best of the morning appearances.

Venus: Venus will be an evening star for the first month of the year but it will move in towards the Sun to pass inferior conjunction on January 30. After this date it becomes a morning star remaining so until the middle of November. Greatest brilliancy occurs on March 7 and greatest elongation on April 11. This will not be a very favorable elongation, however, as the planet will not rise, during most of this time, until the beginning of morning twilight, as indicated by its rising curve on the Time Table.

Mars: Mars will be at opposition on March 22 and nearest the Earth on

March 26, when its distance will be 60 million miles. As is usual at this time, the planet will make a very interesting loop in the sky. Except when near opposition the motion of Mars is toward the east. But on the 12th of February it becomes stationary in right ascension. It will then be about 2° east of Gamma Virginis.

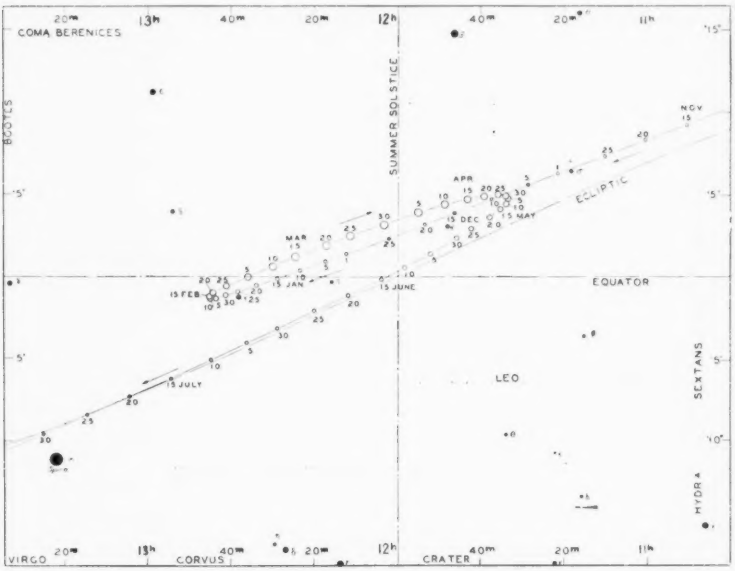

FIGURE 1
THE LOOP OF MARS IN 1950
(Size of disk of Mars is proportional to stellar magnitude.)

The planet will then move westward until the 4th of May when it will once more become stationary in right ascension, after which its motion will again be direct or eastward. This retrograde or westward motion will carry the planet back to where it was at the beginning of December, 1949, a distance of over 30°. This apparent loop of Mars is, of course, an illusion caused by the Earth's much swifter motion. Actually Mars, and all the other planets as well, always move eastward around the Sun. The stellar magnitude of the planet at opposition will be —1.1, which is nearly as bright as Sirius. Mars will be an evening star for the remainder of 1950, gradually growing fainter and moving eastward with increasing rapidity. On December 31 it will set at 7:04 P.M. and its magnitude will be +1.3.

Because of the eccentricity of the orbit of Mars (0.093), the distance of the planet from the Earth at opposition varies from slightly more than 34 million miles when the planet is at perihelion to almost 63 million miles at aphelion. Since its last close approach in 1939, the planet has been progressively farther away at each opposition, but from now on these will diminish until the next close return early in September, 1956. These close approaches of Mars always occur during July, August, or September, when the planet is below the equator,

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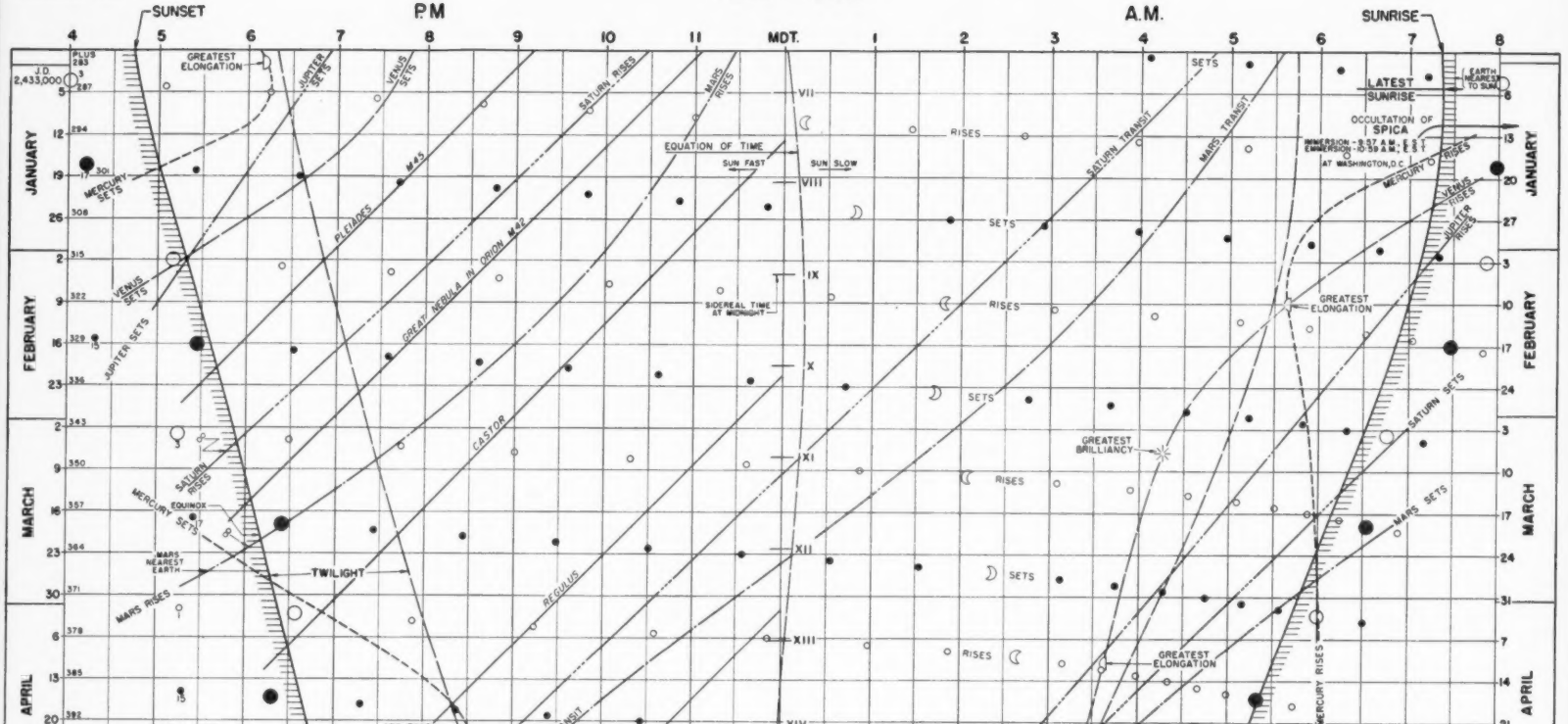
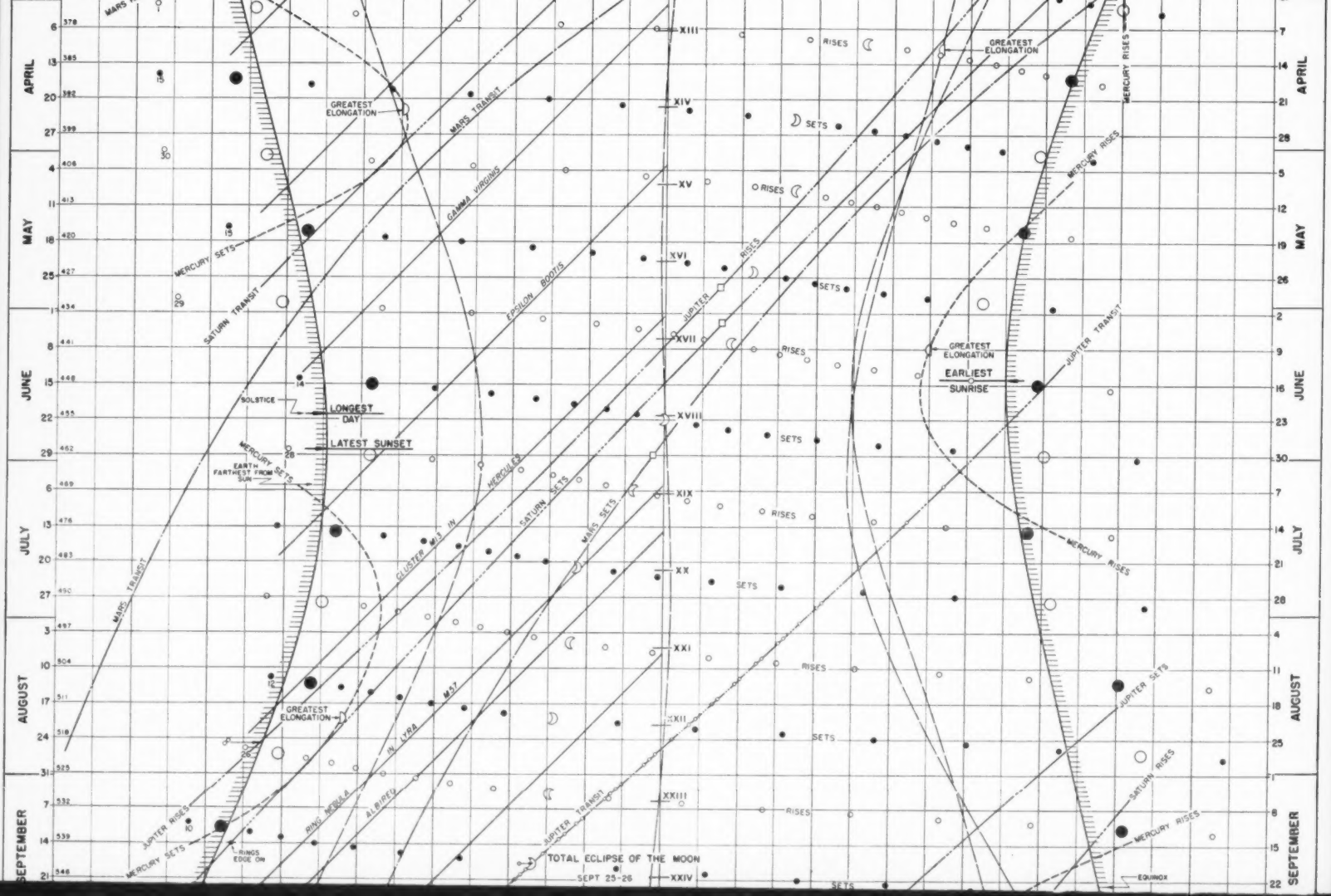
GRAPHIC TIME TABLE OF THE HEAVENS

YEAR 1950

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MARS TRANSIT
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GAMMA VIRGINIS
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SATURN TRANSIT
EPSILON BOOTIS
SOLSTICE
LONGEST DAY
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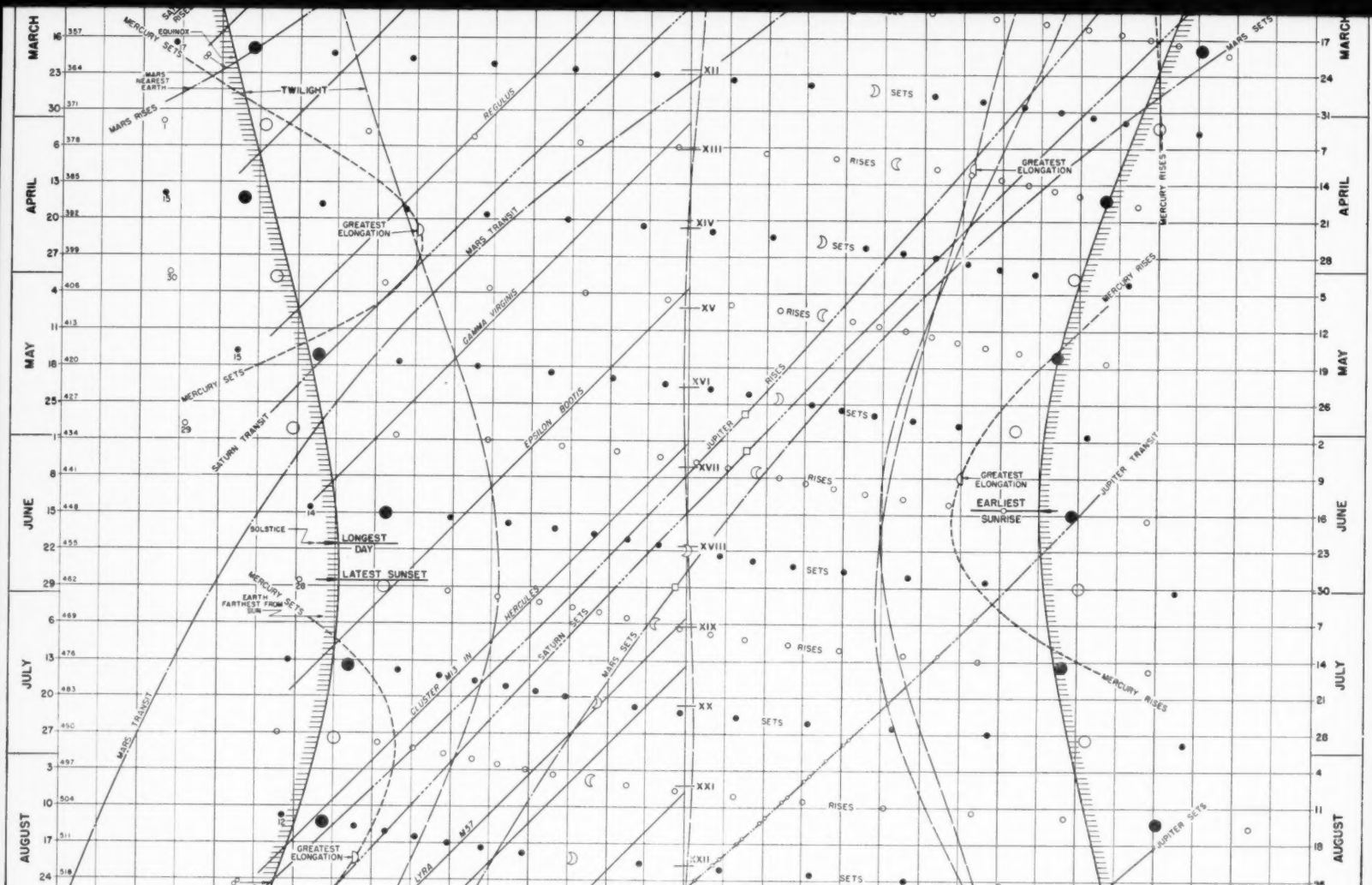
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GAMMA VIRGINIS
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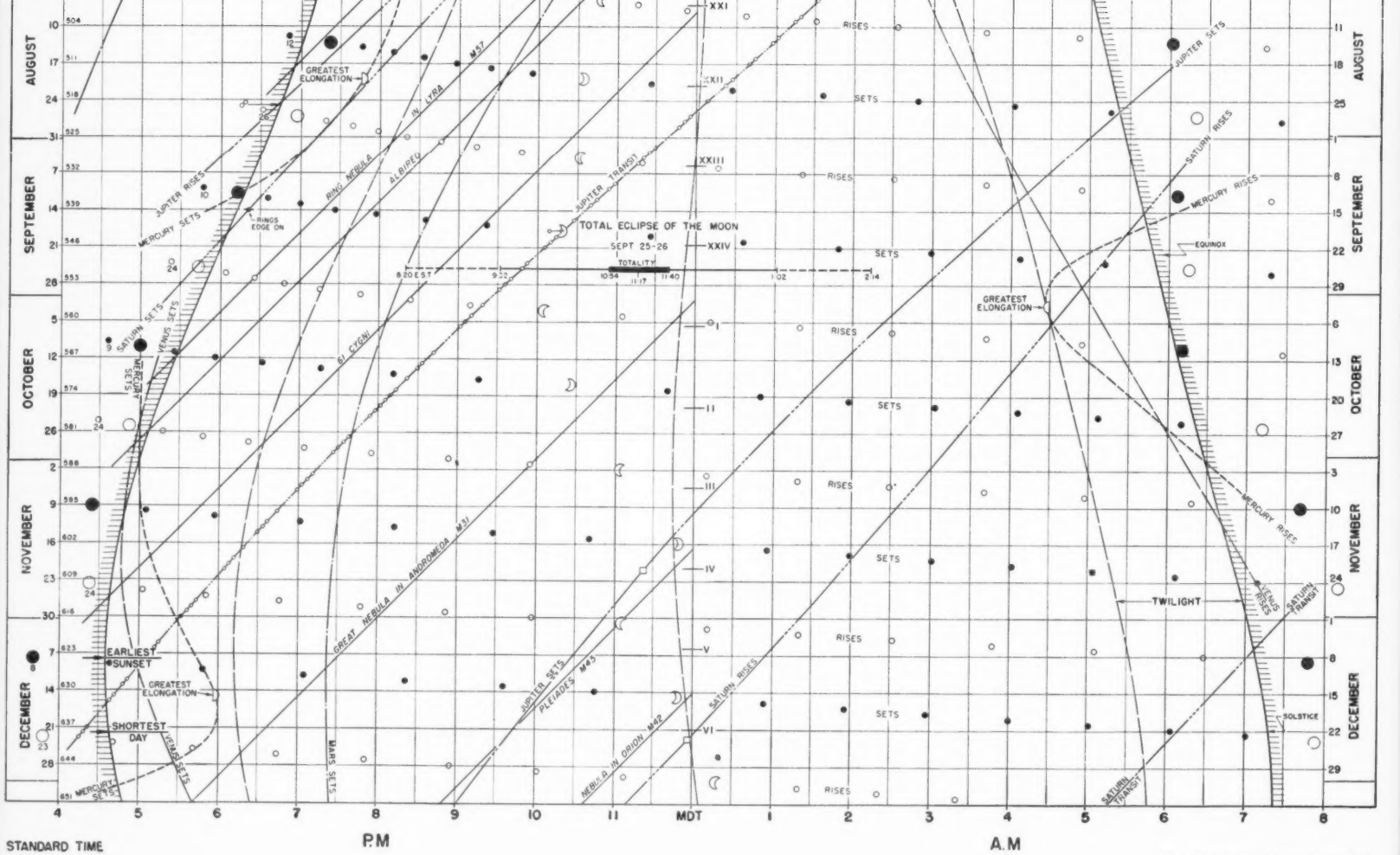

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and as viewed from the northern hemisphere, rather low in the sky. Oppositions occurring in May or June, or October and November, when the planet is not quite so close, are generally more favorable for northern observers since the planet is considerably higher in the sky.

Jupiter: During January, Jupiter will be in the evening sky in the constellation of Capricornus, setting shortly after the Sun and poorly placed for observation. After conjunction with the Sun on February 3, the planet will move into the morning sky. Rising 4 minutes earlier each night, by the 8th of June the planet will rise at midnight. On August 25 Jupiter will be at opposition, rising at sunset. It will then be located in the constellation of Aquarius. Jupiter will remain in the evening sky for the rest of 1950, setting at 9:13 P.M. on December 31.

Jupiter will be an interesting object through the telescope on the nights marked by circles on the "Jupiter Transit" curve. On these evenings, occultations, eclipses or transits of one or more of Jupiter's four brightest moons will take place between the hours of 6 and 10 P.M., C.S.T.

Saturn: On January 1 Saturn will rise at 10:16 P.M. Opposition will take place on March 5 and the planet will then be in the eastern part of Leo. During the spring and early summer Saturn will be well placed for observation, but toward the middle of August it will be too low in the western sky at sunset to be well seen. Conjunction with the Sun occurs on September 15. Saturn then becomes a morning object, rising at 11:24 P.M. by December 31.

Twice, during Saturn's revolution around the Sun of nearly 30 years, the plane of the rings passes through the center of the Earth's orbit. When thus seen edge on the rings are invisible in all but the largest instruments. This phenomenon will occur during 1950, on September 14. At this time, however, the planet will be too near the Sun to be observed, conjunction taking place the next day. When last seen, however, the rings will appear in as closed a position as they will be seen for at least 13 years. At the beginning of the year the Earth will be 1° below the plane of the rings. But this will temporarily increase to 5° below at the end of April, to diminish to zero on September 14. By the end of the year the Earth will be 4° above the plane. This phenomenon will not occur again until 1965.

Uranus: The planets Uranus, Neptune, and Pluto are not included in the Time Table because they cannot be seen without instrumental aid. Uranus will be at opposition on December 29. Its position then will be R.A. $6^h\,32^m$, declination 23½° north. This is approximately 3° east and 1° north of Mu Geminorum. Its magnitude at opposition will be 5.8, so it should just about be visible to a good eye on a clear moonless night.

Neptune: Neptune reaches opposition on April 6, at R.A. $13^h\,1^m$, and declination 4° 46′ south, which is 1½° west of Theta Virginis. This is in a rather starless region, and since the magnitude at this time is 7.7 it should not be difficult to locate with a small telescope.

Pluto: The next opposition of Pluto occurs on February 12, at R.A. $9^h\,28^m$ and declination 23° 41′ north. This is very close to Lambda Leonis but since the visual magnitude of the planet is below the 14th magnitude, it cannot be seen except with large telescopes. Thanks are due to Dr. G. M. Clemence, Director of the Nautical Almanac Office, for this information concerning the location and opposition date of Pluto.

Eclipses

In the year 1950 there will be four eclipses, two of the Sun and two of the

Moon. Only one of these, a total eclipse of the Moon on the night of September 25-26, will be visible from the United States.

I. An annular eclipse of the Sun, March 18, 1950, visible from the south Atlantic Ocean and Antarctic regions.

The circumstances of the eclipse, in Central Standard Time, are as follows: (a 24-hour period is used, beginning at one midnight and ending at the next)

		d	h	m	Longitude ° ′	Latitude ° ′
Eclipse begins	March	18	7	10.8	+108 20	—68 51
Annular Eclipse begins		18	9	8.9	— 48 0	—72 14
Greatest eclipse		18	9	31.9	— 40 54	—61 0
Annular eclipse ends		18	9	54.9	— 34 30	—49 35
Eclipse ends		18	11	52.7	— 4 3	—10 36

Magnitude of the Annular eclipse = 0.928 (Sun's diameter = 1.0)

II. A total eclipse of the Moon, April 2, 1950, visible in whole or in part, in Europe, Asia, Africa, eastern South America, and the Arctic and Antarctic regions.

The circumstances are, in Central Standard Time:

		d	h	m
Moon enters penumbra	April	2	12	9.3
Moon enters umbra		2	13	9.0
Total eclipse begins		2	14	29.5
Middle of the eclipse		2	14	44.1
Total eclipse ends		2	14	58.7
Moon leaves umbra		2	16	19.2
Moon leaves penumbra		2	17	18.8

Magnitude of the eclipse = 1.039 (Moon's diameter = 1.0)

III. A total eclipse of the Sun, September 11, 1950, the path of totality beginning at sunrise near the north pole and moving across the extreme northeastern tip of Siberia and ending in the north Pacific at sunset.

The circumstances of this eclipse, in Central Standard Time, are given below:

		d	h	m	Longitude ° ′	Latitude ° ′
Eclipse begins	September	11	19	23.2	— 59 14	+63 45
Central eclipse begins		11	20	50.1	+ 66 42	+85 10
Central eclipse begins at apparent noon		..	..	..	.. ..	.. ..
Central eclipse ends		11	22	27.0	+154 35	+34 23
Eclipse ends		11	23	53.6	+178 46	+ 6 34

IV. A total eclipse of the Moon, September 25-26, 1950, visible throughout the United States, the beginning visible in North and South America, the Arctic and Antarctic regions, the Atlantic Ocean, Europe, Africa and southwestern Asia; the ending visible generally in the central and eastern Pacific, North and South America, the Arctic and Antarctic Regions, the Atlantic Ocean, and the extreme western parts of Europe and Africa.

The Time Table indicates the various circumstances in Eastern Standard Time. If the observer is located in some other time belt he must make allowance for the number of hours difference between his time and Eastern Standard.

The circumstances of this eclipse, in Central Standard Time, are as follows:

		d	h	m
Moon enters penumbra	September	25	19	20.0
Moon enters umbra		25	20	31.5
Total eclipse begins		25	21	53.8

	d	h	m
Middle of eclipse	25	22	16.7
Total eclipse ends	25	22	39.6
Moon leaves umbra	26	0	1.9
Moon leaves penumbra	26	1	13.5

Magnitude of the eclipse = 1.084 (Moon's diameter = 1.0)

OCCULTATIONS

As seen from the United States only one bright object will be occulted by the Moon during 1950. This will be a daylight occultation of Spica (Alpha Virginis) on the morning of January 11. As seen at Washington, D. C., immersion takes place at 9:57 A.M., E.S.T., and emersion at 10:59 A.M., E.S.T. From longitude +91° 0′ and latitude +40° 0′, these times are: immersion 8:42 A.M., C.S.T., and emersion 9:46 A.M., C.S.T. For the times at other locations reference should be made to the *American Ephemeris and Nautical Almanac*.

Maryland Academy of Sciences, December 6, 1949.

The Planets in February, 1950

By RAYMOND H. WILSON, JR.

NOTE: The time employed is Central Standard Time unless otherwise indicated. The phenomena have been chosen and described for the North American continent, and especially for the United States. The basic data have been taken principally from the *American Ephemeris and Nautical Almanac*.

Sun. The sun will continue its motion northward from its wintry declinations, so that by the end of the month it will be only 8 degrees south of the equator.

Moon. The phases of the moon will occur as follows:

Full Moon	February	2	4 P.M.
Last Quarter		9	1 P.M.
New Moon		16	5 P.M.
First Quarter		24	8 P.M.

The moon will be at perigee on February 6.

Evening and Morning Stars. Saturn and Mars will be rising in the later evening, while Venus will decorate dawns of the latter half of the month.

Mercury. Mercury will stand 25 degrees west of the sun on February 10, so it may be visible in the southeast before sunrise during most of the month. It will be 8 degrees south of Venus on the 16th.

Venus. This planet will be rapidly receding westward from the sun, so that, from about the middle of the month onward, it will be quite conspicuous in the dawn.

Mars. The red planet will come to a stationary point on the 12th and begin retrograding westward toward Spica. Most of the month it will be within a degree of that star, which it will outshine by over a magnitude.

Jupiter. Its conjunction with the sun on the 3rd will preclude visibility of Jupiter during most of the month. It might be glimpsed in the dawn on the last few days, just east of the planet Mercury.

Saturn. Located in the constellation Leo, which rises at about 8 P.M., Saturn

will be conveniently placed for later evening observation. Again the moon will pass only a few minutes south of it, at 4 A.M. on the 5th.

Uranus. Uranus will be moving very slowly westward at about a degree northeast of the fourth-magnitude star 1 Geminorum.

Neptune. Neptune will be moving north-northwestward at about half a degrees west of θ Virginis.

Department of Mathematics, Temple University, Philadelphia, Pa.
December 3, 1949.

Asteroid Notes

By HUGH S. RICE

The new French bulletins, which have been issued since 1949 January 1, are of real interest to observers who read French. The name of the bulletins is *Documentation des Observateurs*, and they are published under the auspices of the Institut d'Astrophysique de Paris, 98 bis, Boulevard Arago, Paris 14e, France. The officer in charge is Monsieur R. Rigollet. The annual fee is 750 francs (approx. $2.25) for service by ordinary mail [or "surface mail" as the term is used in Argentina], or 1500 francs for air mail. Surface mail takes about 10 to 12 days to New York, whereas the air mail occupies but 2 to 3 days, and sometimes less than 2 days. The bulletins arrive in excellent condition, being commonly packed with cardboard.

These "DOB" bulletins are printed leaflets, often accompanied by a supplement (*annexe*) in mimeograph form. As suggested, the DOB are typical observers' material and we know of nothing else like them at present. Notable is the fact that they are highly illustrated. They do not compete with professional bulletins such as the *Announcement Cards* of the Harvard College Observatory, but are for telescope users, and cover a miscellany of subjects, such as special conjunctions, variable stars with diagrams of the field and stellar magnitudes, meteor showers, comet ephemerides and diagrams, lunar eclipses with diagrams of field, asteroid ephemerides and special remarks and plottings of the apparent path and magnitude-sequence of the stars in the region, diagrams of field of view of planets Saturn to Pluto, drawings of lunar formations with text on particular features, phenomena of the ionosphere region of the earth's atmosphere, etc. There is also considerable observing news by various observers over the world, due attention being given to astronomers in the U.S.

Of the brighter asteroids, the next ones in order of opposition, after those we have given before, are 115 THYRA and 181 EUCHARIS. They are both 10th magnitude planets in Leo, and both are in opposition in February, 1950. The ephemerides given here are from the annual published in the United States, but the computations may not have been done here. Comparison of the positions with those given in the Russian book of minor planets shows that the Russians give the right ascension of THYRA as 3^m greater and the declination as 4′ less, and the right ascension of EUCHARIS as 21^m less and the declination 2′ less, than in the U.S. book. THYRA is found west of Alpha Leonis. EUCHARIS is in conjunction with this star on February 18 at 0^h U.T., and is then 2° 7′ due north of the star.

ASTEROID EPHEMERIDES

0^h U.T. Equinox 1950

115 THYRA			181 EUCHARIS		
1950	α h m	δ ° ′	1950	α h m	δ ° ′
Jan. 9	9 46.2	+13 21	Jan. 19	10 23.4	+ 8 33
19	9 37.4	+13 2	29	10 19.1	+10 22
29	9 26.3	+12 53	Feb. 8	10 12.9	+12 19
Feb. 8	9 14.3	+12 49	18	10 5.8	+14 20
18	9 2.8	+12 46	28	9 58.7	+16 14
28	8 53.3	+12 40	Mar. 10	9 52.6	+17 57
Mar. 10	8 47.3	+12 27	20	9 48.4	+19 18

Hayden Planetarium, American Museum of Natural History, New York, 1949 December 25.

Occultation Predictions for February, 1950

(Taken from the *American Ephemeris*)

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

			IMMERSION				EMERSION			
Date 1950	Star	Mag.	Greenwich C.T.	*a*	*b*	Angle E from N	Greenwich C.T.	*a*	*b*	Angle E from N
			h m	m	m	°	h m	m	m	°
OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′										
Feb. 1	*c* Gemi	5.4	10 16.0	−0.8	+0.2	40	10 36.2	+1.4	−2.8	355
1	λ Canc	5.9	22 37.9	−0.2	+1.1	98	23 39.7	−0.6	+1.0	278
4	37 Leon	5.7	1 26.3	−0.6	−0.3	136	2 27.0	−1.0	+1.2	272
7	*g* Virg	5.7	12 48.1	..	..	49	13 11.1	..	..	8
10	*A* Scor	4.8	11 46.2	−1.9	−0.3	98	13 4.9	−1.7	−1.2	300
10	3 Scor	5.9	12 29.7	−2.1	+0.2	57	13 21.5	−1.5	−2.0	337
22	27 Arie	6.4	22 33.9	−1.3	+2.2	28	23 45.0	−1.9	−1.6	273
25	38 B.Auri	6.5	23 42.1	−1.8	+3.1	36	0 45.3	−2.1	−2.9	305
28	47 Gemi	5.6	6 32.9	+0.6	−2.6	153	7 13.0	−0.6	−0.7	240
28	BD+27°1337	6.4	7 13.2	..	..	20	7 17.0	..	..	13
OCCULTATIONS VISIBLE IN LONGITUDE +91° 0′, LATITUDE +40° 0′										
Feb. 1	*c* Gemi	5.4	10 8.0	−0.5	−0.1	80	10 57.1	+0.5	−1.9	319
4	37 Leon	5.7	1 18.9	−0.3	−0.2	137	2 11.4	−0.3	+1.4	265
7	*g* Virg	5.7	12 17.4	−1.9	−0.7	80	13 10.0	−0.6	−2.4	347
7	BD−8°3495	6.4	13 16.2	−0.6	−2.4	166	14 3.8	−1.1	−1.2	258
9	43 B.Libr	6.1	13 9.4	−1.1	−2.1	164	14 0.1	−2.0	−0.5	247
10	*A* Scor	4.8	11 15.5	−1.4	−0.2	125	12 33.4	−1.9	−0.3	285
10	3 Scor	5.9	11 45.1	−2.2	+0.5	86	12 57.2	−1.5	−1.1	321
25	χ Taur	5.5	6 1.4	+0.2	−1.7	109	6 55.5	0.0	−0.6	244
25	38 B.Auri	6.5	23 9.4	−0.7	+4.2	24	0 6.0	−2.9	−1.9	303
28	BD+27°1337	6.4	6 48.1	−1.0	−0.9	79	7 43.6	+0.3	−2.2	317
28	134 B.Gemi	6.5	8 49.7	+0.4	−1.7	129	9 38.6	+0.2	−1.0	263

Date 1950	Star	Mag.	IMMERSION Greenwich C.T.	*a*	*b*	Angle E from N	EMERSION Greenwich C.T.	*a*	*b*	Angle E from N
			h m	m	m	°	h m	m	m	°
Occultations Visible in Longitude +98° 0′, Latitude +31° 0′										
Feb. 1	*c* Gemi	5.4	10 16.6	−0.2	−1.4	110	11 14.3	+0.2	−1.4	293
5	σ Leon	4.1	8 23.0	..	..	67	8 55.6	..	..	18
7	*g* Virg	5.7	12 12.2	−1.9	−1.1	108	13 24.6	−1.1	−2.1	324
7	BD−8°3495	6.4	13 47.2	..	..	207	13 51.4	..	..	222
10	*A* Scor	4.8	11 15.6	−0.4	−1.6	160	12 15.3	−2.8	+0.8	257
10	3 Scor	5.9	11 30.2	−1.7	−0.2	116	12 52.8	−2.0	−0.6	297
24	66 Arie	6.1	4 35.3	−0.9	+0.2	55	5 35.6	+0.1	−1.6	285
25	χ Taur	5.5	6 31.5	..	..	164	6 46.2	..	..	192
25	38 B.Auri	6.5	22 35.3	−0.9	+2.8	44	23 53.1	−2.5	+0.2	276
26	47 B.Auri	6.1	2 16.1	−2.7	+3.3	37	3 18.0	−1.8	−3.9	313
28	BD+27°1337	6.4	6 53.6	−0.7	−1.6	114	7 59.3	−0.3	−1.5	286
28	134 B.Gemi	6.5	9 13.7	+1.2	−2.8	164	9 43.3	−0.5	+0.2	231
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′										
Feb. 1	*c* Gemi	5.4	9 58.4	−0.5	−2.2	136	11 1.0	−0.9	−1.2	270
5	σ Leon	4.1	7 31.8	−1.6	+0.7	99	8 35.5	−0.9	−1.9	337
7	*g* Virg	5.7	11 28.9	−1.2	−1.3	141	12 44.9	−1.8	−1.2	300
10	3 Scor	5.9	11 10.0	−0.2	−0.6	146	12 11.1	−1.7	+0.9	269
12	*W* Sgtr	4.7	14 30.3	−0.8	−1.0	149	15 20.2	−2.7	+1.8	225
13	183 B.Sgtr	6.2	14 21.6	−1.1	+0.6	113	15 33.2	−2.0	+1.3	245
24	66 Arie	6.1	4 7.1	−1.7	+0.7	51	5 20.1	−0.9	−1.8	279
26	354 B.Taur	6.3	8 6.7	−1.0	+0.2	50	8 50.7	+0.8	−2.6	319
28	BD+27°1337	6.4	6 22.5	−1.1	−2.5	137	7 32.6	−1.8	−0.7	260

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVER, President

In our files are great numbers of maps, sent in by our members, on which the radiants have never been reduced, simply because I have not had the time. On many maps indeed, particularly of those who do not observe except occasionally, the plotting is so obviously inferior, from lack of both study and practice, that it would be useless to spend time upon them. But for many the contrary is the case. Among the latter Paul Anderson of Beechwood, Mich., observed and plotted 1506 meteors from Sept., 1940, to Nov., 1942, inclusive. To work these up properly has taken a great deal of time but finally the results are ready and appear in Table I. This observer is to be congratulated on his contributions, and the long delay in their reduction is a matter of regret to me. It will be noted that several of the chief showers were observed, often with success. Only with the Perseids are the radiants often poor, due mostly to an apparent tendency, on our Map I, to plot the meteors too far up, *i.e.*, towards the bright stars in Cassiopeia. As similar tendencies are not elsewhere shown on his maps, it is difficult to explain. As usual, only radiants of southern declination, or determined in months of low rates, or for some other exceptional reason, are given if there are less than 4 meteors diverging from them. The dates are given in (old) G.M.T. When no fraction of a date is given, it means that results from more than one night are used. The number of nights so combined is indicated in the

Remarks column by a number followed by N. Usually the nights were consecutive. The other numbers refer to published A.M.S. radiants which are considered to be probably confirmative. But the search for such confirmations has been most incomplete so doubtless others exist in our files. Rates based upon combined counts by more than one observer are not given. Also they are not derived for one observer when F is less than 0.5, as for such poor sky conditions rates have little comparative value.

TABLE I

AMS No.	Date	α	δ	No. of Meteor	Wt.	Remarks
	1940					
3058	Sept. 11.82	36	+20	4	G	
3059	Sept. 11.82	66	+34	5-7	FG	
3060	Oct. 3.79	73	— 3	3	F	
3061	Dec. 31.78	168	+ 9	3-4	G	
	1941					
3062	July 23	10	+44	7—	F	3 N; 5, 26
3063	June 24.79	11	+17	5	FG	
3064	Nov. 24.73	22	+44	12	G	Very diffuse; Bielids
3065	Oct. 14.66	36	+56	5	G	
3066	Aug. 11.78	36	+58	18+	P	Diffuse, Perseids
3067	Aug. 12.70	44	+56	6	VG	Perseids
3068	Mar. 4.59	80	+ 4	6	G	
3069	Oct. 21.82	90.5	+13.5	7	VG	Orionids
3070	Feb. 28.71	170	+19	4	P	2402?
3071	Mar. 28	200	+16	5	FG	4 N; 3073
3072	Apr. 24.1	202	+25	4	FG	2 N; 918
3073	Apr. 4.74	209	+18	7	G	3071
3074	June 16.67	270	+54	5	FG	1009?, 1022
3075	June 19	299	+43	7	G	3 N; 3076
3076	June 24.79	305	+48	5+	FG	2614, 3075
3077	July 21.2	328	+43	4	G	2 N
3078	June 19.82	329	+29	5	FG	
3079	July 26.80	337	—14	10+	G	δ Aquarids
3080	July 24.6	342	+24	10±	G	4 N
3081	July 28.76	341	—15	14+	FG	Diffuse, δ Aquarids
3082	July 26	342.5	+30	6+	FG	4 N; 2420
	1942					
3083	Aug. 11.69	33	+55	4	P	Perseid
3084	Aug. 3.68	34	+56	6	P	"
3085	Aug. 2.70	41	+55	3	P	"
3086	Nov. 14.82	57	—23	3-5	FG	
3087	Nov. 14.82	65	—16	5	F	2094
3088	Nov. 14.82	73	+36	5	G	152, 155, 1638, 1320
3089	Nov. 14.82	76	+49	3	G	
3090	Nov. 14.82	86	+64.5	3	G	
3091	Nov. 14.82	151	+18	2	—	Leonids; only ones plotted
3092	Mar. 12	197	+ 8	6	FG	
3093	May 8.8	240	+60	4+	G	2 N
3094	May 7.81	258	+32	4	F	3095, 993
3095	May 9.80	260	+33	4+	G	3094, 993
3096	Apr. 20.77	266	+57	5	VG	
3097	Apr. 20.77	271	+31.5	12	G	Lyrids
3098	May 6.74	283	+64	4-5	G	
3099	May 7.81	293	+42	5	G	3100
3100	May 9.80	294	+45	5-7	G	3099
3101	May 9.80	295	+36	7	FG	
3102	May 6.74	303	+38	5-6	VG	
3103	May 9.80	337	+ 6	3-4	P	η Aquarids
3104	May 6.74	233	—18	4	FG	

NOTE: The above radiants are all from the maps of Paul Anderson.

Table II contains data for July and August, thus covering the two chief annual summer showers, the Delta Aquarids and the Perseids. The maximum of the latter was spoiled badly from both moonlight (the Moon being full on Aug. 8) and in many areas from clouds. Particular mention should be made of P. Barnes, F. B. Eason, and Miss A. K. Jensen. The first has become one of our best and most active observers. We do not find in our files records of his meteors 1949 No. 691 to 770 inclusive. They are either misplaced here or lost in the mails from Pakistan. This explains the gap in his data from July 28 to Aug. 28. Miss Jensen has for several years past sent us valuable hourly rates (counting only) covering the two showers mentioned. As for F. B. Eason, our present regional director in North Carolina, we cannot commend too heartily his personal work and the success he has had in arousing great interest in meteoric astronomy among others in his state. In fact, what is recorded in Table II from his group at Wilson, N. C., covers only a fraction of what has been done there. The records of one observer have not yet reached me; those of two others, both containing several hundred meteors, require some further study, and I am unwilling to hold up this paper longer. But full justice will be done to these other observers later. Meantime I consider it of interest to show what was accomplished by a goodly number of our observers and their assistants. Incidentally I know of work by members in other states, done during these months, that has not reached me, nor has that of our distinguished member Prof. Khan of Hyderabad in India, who is always one contributing a very large report of plotted meteors.

In mentioning what has been accomplished by the enthusiasm of F. B. Eason the thought strikes me with some wonder why, with all the astronomical societies in America, other leaders such as he do not come forward in many of our states. As it is, while several other persons working singly have evidently made great contributions in 1949, in no other state but North Carolina do we find a fully active group who by working together help maintain the interest of each individual and also doubtless help each other to become more skillful observers. I respectfully suggest that others follow their excellent example.

All members are requested to send in their dues of $1 for 1950, if they have not already done so, without forcing us to send out reminders. I was much astonished by one of our members last year suggesting that if I wanted the dues I should give my address! So for the benefit of any who do not know it, please look at the end of this article where it will be found. As usual, the Flower Observatory Reprint with the 1949 A.M.S. work should be ready by March. It will be sent to all members whose dues have been paid. When members need maps, blanks or other supplies, they are requested to write well ahead of when needed, as it is often quite impossible to get such things off within a day or so of the request, as some seem to expect. Two weeks should be given.

We sincerely hope that 1950 will be a year of great accomplishment in the A.M.S. and that our contributions to meteoric astronomy will grow in value as well as amount.

TABLE II

Observer, Station, and Time	Date 1949	Began	Ended	Min.	Met.	F	Hourly Rate Unc.	Obs.	C
Wilson, N. C.—E.S.T.									
Eason, F. B.	July 26	8:50	15:30	400	70	1.0	..	3	PD
" "	27	8:45	15:30	405	50	1.0	8	1	P
" "	28	8:15	13:00	285	31	1.0	7	1	P
" "	28	13:00	14:00	60	7	0.5	7	1	P

Observer, Station, and Time	Date 1949	Began	Ended	Min.	Met.	F	Hourly Rate Unc.	Obs.	C
Eason, Mrs. F. B.	27	8:45	13:15	270	23	1.0	5	1	D
" "	28	8:15	12:10	235	25	1.0	6	1	D
Painter, Mrs. Wm.	27	8:45	11:46	181	30	1.0	..	2	D
" "	28	8:15	11:40	205	57	1.0	..	2	D
Laramie, Wyo.—M.S.T.									
Beetle, Mrs. D. E.	Aug. 10	12:05	13:05	60	3	0.2	..	1	P
" "	11	9:00	10:00	60	8	0.3	..	1	P
Tucson, Ariz.—M.S.T.									
Burlinson, M. A.	11	8:10	9:10	60	5	0.4	..	1	C
Burlinson, Mrs. M. A.	11	8:10	9:10	60	4	0.4	..	1	C
Wilson, N. C.—E.S.T.									
Eason, Mrs. F. B.	Aug. 3	9:30	10:15	45	2	0.3	..	1	D
" "	5	12:15	16:00	225	23	0.8	6	1	D
" "	8	12:00	14:05	125	8	0.4	..	1	D
" "	9	8:00	12:00	240	8	0.4	..	1	D
" "	10	8:00	12:00	240	4	0.4	..	1	D
" "	11	12:00	16:00	240	16	0.4	..	1	D
Eason, F. B.	9	12:00	15:30	210	12	0.4	..	1	P
" "	10	12:00	16:00	240	11	0.4	..	1	P
" "	11	12:00	16:30	270	26	0.4	..	1	P
Auge, F.	11	14:	16:10	...	10	0.4	..	1	D
Bissett, Lynn	8	12:00	14:05	125	5	0.4	..	1	D
" "	9	8:15	14:00	345	8	0.4	..	1	D
" "	11	10:30	16:30	360	28	0.4	..	1	D
Ingram, Texas—C.S.T.									
McCord, Mrs. F. C.	11	8:45	10:47	...	10	0.4	..	2	D
Seymour, Conn.—E.S.T.									
Tifft, Miss L.	14	9:20	10:20	60	14	0.7	14	1	C
Tifft, W. G.	14	9:20	10:20	60	18	0.7	18	1	C
Philadelphia, Pa.—E.S.T.									
Klatt, P.	16	9:00	12:00	180	4	1.0	..	2	P
" "	July 28	15:52	17:35	103	26	0.5	..	2	D
Bronx, N. Y.—E.S.T.									
Taleporos, A.	July 31	10:30	11:45	75	3	0.4	..	1	D
" "	Aug. 14	11:50	13:00	70	11	0.6	9	1	D
Lyallpur, Pakistan—I.S.T.									
Barnes, P.	July 13	9:00	10:20	80	5	1.0	4	1	P
" "	14	9:00	11:30	150	10	0.9	4	1	P
" "	15	9:30	11:30	120	11	0.8	6	1	P
" "	16	9:00	11:30	150	10	0.7	4	1	P
" "	17	9:30	12:15	165	16	0.9	6	1	P
" "	18	9:00	11:30	150	5	0.4	..	1	P
" "	20	9:00	10:30	90	4	0.5	3	1	P
" "	21	8:40	12:00	200	5	0.5	2	1	P
" "	22	8:50	11:10	140	3	0.5	1	1	P
" "	23	8:30	12:30	240	24	0.8	6	1	P
" "	24	8:40	10:20	100	6	0.8	4	1	P
" "	25	8:45	12:00	195	18	0.8	6	1	P
" "	26	9:30	11:30	120	15	1.0	8	1	P
" "	27	8:50	12:00	190	19	0.6	6	1	P
" "	28	9:00	11:30	150	?	0.7	?	1	P
" "	Aug. 28	9:00	10:45	105	10	0.8	6	1	P
Meredith, N. H.—E.S.T.									
Knowles, J.	July 21	12:30	15:00	150	39	1.0	16	1	P
" "	26	13:00	15:08	120	32	0.9	16	1	P
" "	28	13:00	15:00	120	36	1.0	18	1	P
" "	Aug. 1	12:30	15:00	150	47	1.0	19	1	P
" "	4	12:30	13:35	65	12	0.7	11	1	P
" "	14	13:05	14:30	85	6	0.7	4	1	P
" "	16	12:00	15:00	180	22	0.7	7	1	P
" "	20	13:00	15:10	130	31	1.0	14	1	P

Observer, Station, and Time	Date 1949	Began	Ended	Min.	Met.	F	Hourly Rate Unc.	Obs.	C
Meredith, N. H.—E.S.T.									
Knowles, J.	Aug. 21	13:19	15:39	140	37	1.0	16	1	P
" "	24	12:00	14:30	150	28	1.0	11	1	P
" "	30	12:41	13:46	65	15	0.9	14	1	P
Baldwin, J. I.	July 28	13:00	14:00	60	19	1.0	19	1	C
Nauvoo, Ala.—C.S.T.									
Scott, T.	Aug. 25	7:55	9:55	120	16	0.8	8	1	P
" "	26	8:30	11:00	150	18	0.7	7	1	P
Portland, Ore.—P.S.T.									
Widner, R.	July 29	9:48	11:23	95	17	0.8	12	1	P
" "	30	9:51	11:51	120	26	0.8	13	1	P
" "	Aug. 1	11:15	12:30	75	15	0.7	12	1	P
" "	8	10:20	12:20	120	25	0.3	12	1	P
" "	13	11:07	11:37	30	10	0.5	20	1	P
" "	17	11:05	12:05	60	6	0.6	6	1	P
" "	18	10:18	13:18	180	35	0.8	12	1	P
" "	19	11:47	13:47	120	25	0.7	12	1	P
" "	22	10:36	12:11	95	15	0.6	11	1	P
" "	23	8:58	9:58	60	10	0.7	10	1	P
" "	23	10:42	12:42	120	19	0.8	10	1	P
" "	25	11:15	12:35	80	14	0.8	10	1	P
Silverton, Ore.—P.S.T.									
Jensen, Miss A. K.	July 28	11:48	13:48	120	55	1.0	18	1	C
" "	Aug. 13	13:09	14:09	60	16	0.6	16	1	C
" "	14	8:50	9:50	60	13	0.5	13	1	C
" "	15	9:30	10:15	45	6	0.3	..	1	C
" "	16	9:32	10:32	60	9	1.0	9	1	C
" "	17	9:15	10:15	60	10	0.8	10	1	C
" "	18	9:33	10:33	60	12	1.0	12	1	C
" "	19	9:09	10:09	60	13	1.0	13	1	C
" "	22	9:24	10:24	60	14	1.0	14	1	C
" "	23	9:29	10:29	60	15	1.0	15	1	C
" "	25	13:57	14:57	60	26	1.0	26	1	C
" "	26	12:45	13:45	60	22	1.0	22	1	C
" "	27	9:27	9:57	30	6	0.5	12	1	C
" "	27	12:50	13:50	60	12	1.0	12	1	C
Elkhart, Ind.—E.S.T.									
Swihart, T.	July 28	13:50	15:20	90	17	0.9	11	1	P
" "	30	13:35	15:15	100	26	1.0	16	1	P
Blair Lake, N. H.—E.S.T.									
Dupee, Mrs. D. S.	Aug. 10	11:00	14:00	120	16	0.3	..	1	D
" "	16	10:45	13:15	120	15	0.6	8	1	D
Cape Elizabeth, Me.—E.S.T.									
Dole, R. M.	July 29	10:00	12:15	135	51	1.0	23	1	P
" "	31	10:15	11:15	60	16	1.0	16	1	P
" "	Aug. 1	10:15	11:15	60	11	1.0	11	1	P
" "	14	9:00	10:45	95	15	0.4	..	1	P
" "	15	10:15	10:45	30	9	0.9	18	1	P
" "	19	10:00	11:00	60	13	1.0	13	1	P
" "	20	10:00	11:00	60	3	0.5	3	1	P
" "	21	10:00	11:00	60	16	1.0	16	1	P
" "	23	9:15	10:15	60	19	0.9	19	1	P
" "	25	9:00	10:00	60	10	0.4	10	1	P
" "	29	9:30	10:30	60	24	1.0	24	1	P
Memphis, Tenn.—E.S.T.									
Burt, P.	July 28	13:40	15:00	80	18	1.0	14	1	P
" "	29	13:30	14:30	60	7	1.0	7	1	P

Flower Observatory, Upper Darby, Pa., 1950 January 2.

Contributions of The Meteoritical Society

(Known Formerly as The Society for Research on Meteorites)

Edited by FREDERICK C. LEONARD
Department of Astronomy, University of California, Los Angeles 24

The Possible Preservation in Concretions of Traces of Ancient Meteorites*

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ABSTRACT AND INTRODUCTION

The absence not only of admittedly genuine meteorites but also of the supposed glass meteorites (tektites) from all but the more recent geological formations is a well-established and intriguing fact. It is not known whether to interpret this absence as evidence that meteorites did not fall in earlier geological times or to look upon it as proof that such meteorites as fell long ago have been entirely destroyed or altered into unrecognizable forms under lengthy attack by the agencies of weathering and corrosion. Most meteoriticists seem to favor the second alternative. The situation just described is closely analogous to that encountered by geologists in investigations of the mineral aggregates present in the geological column. Here, too, it has been customary to explain the greater simplicity of the mineral assemblages in the older strata as the result of long-acting solvent and corrosive agents. But this hypothesis of the geologist, like the corresponding hypothesis made by meteoriticists to explain the absence of meteorites in the earlier formations, has, up to the present, lacked supporting evidence.

In this paper, it is pointed out that very recently such evidence has been supplied by the sedimentary petrologists, who have shown that calcareous concretions in sandstones may preserve within themselves in unaltered or almost unaltered condition heavy minerals and other substances that have disappeared entirely from, or have been greatly altered in the sandstone beds containing the concretions. The results of such modern sedimentary petrological study on the stability of minerals in sandstone strata and in calcareous concretions in the same sandstone suggest that, altho concretions may not be the missing ancient meteorites, as the uninitiated so often mistakenly and stubbornly insist, nevertheless, traces of hitherto undetected early meteoritic and tektitic falls may be preserved within impervious concretions. In particular, it seems open to question whether shards of silica glass found in certain Miocene concretions are fragments of tektites or of volcanic glass. It is urged that meteoriticists systematically investigate the materials preserved within large numbers of impervious concretions. Suggestions are made in regard to the meteoritical evidence to be sought for and the search procedures to be employed.

Up to the present, concretions have been one of the banes of the meteoriticist's existence, since they are habitually mistaken for meteorites by the uninformed, and the erroneous identification is clung to with a tenacity almost beyond belief. Recent investigations by sedimentary petrologists, however, strongly suggest that the concretions may prove to be natural "time capsules," in which evi-

*Read at the 12th Meeting of the Society, Los Angeles, California, 1949 September 6-8.

dence may well have been preserved that will give definite answer to one of the oldest and most puzzling questions in meteoritics. We have reference to the well-known and often debated absence of meteorites from all but the more recent of the geological formations.[1] This dearth of specimens in ancient rocks is quite as noticeable for the supposed glass meteorites (tektites) as for the iron, stone-iron and iron-stone, and stone meteorites (siderites, siderolites, and aerolites).

One clue to a possible cause of the disappearance of the tektites from the older strata is furnished by the convincing evidence of chemical corrosion that the remarkably sculptured surfaces of these bodies exhibit. Again, from Thoulet's time onward, it has been recognized that, as one ascended in the geological column, the mineral aggregates found in the sedimentary formations increased in complexity; and the greater simplicity of the mineral assemblages in the older strata has been customarily explained by geologists by assuming that, under solvent and corrosive action, certain minerals once present in these strata have disappeared entirely from them.

From the viewpoint of meteoritics, the evidence of the profoundly sculptured surfaces of the tektites and that afforded by Thoulet's observation and its customary interpretation are equally unsatisfying, for we are told how the meteorites *may* have come to *disappear* from the older geological formations without being given any assurance that such bodies were actually ever present in these formations. Until very recent studies on the differential stability of minerals, the geologists were in the same unsatisfactory predicament, for their quite reasonable hypothesis to explain Thoulet's observation had nothing more to support it than the equally reasonable hypothesis advanced by the meteoriticists to explain the curious observed absence of meteorites from the more ancient rocks. As a result of modern studies on differential mineral stability by the sedimentary petrologists, however, the hypothesis advanced by the geologists has now received strong support, for it has been found that concretions in sandstone may preserve within themselves in unaltered or in practically unaltered condition heavy minerals and other materials that either are found in greatly altered form in the sandstone beds surrounding the concretions or have disappeared entirely from those beds.[2] The absence of such heavy-mineral aggregates from a given sandstone can no longer be accepted as proof that such aggregates were never present in that particular rock.

This discovery by the sedimentary petrologists, reminiscent of the fact that concretions may be abundantly fossiliferous even when the beds in which they occur are almost destitute of fossils, is obviously of first-rate importance to meteoritics. It suggests that the meteoriticists, too greatly influenced by the compelling evidence of the effectiveness of long-continued *extraconcretionary* corrosion upon even such resistant materials as the probably cosmic tektites and the certainly terrestrial garnets, have been too prone to conclude that there is no chance of discovering tektites and meteorites in ancient rocks.

Certainly the results recently secured by detailed and systematic study of the differential stability of minerals in sandstone strata and in impervious calcareous concretions in these same sandstones strongly argue that, in the future, meteoriticists should be less inclined to content themselves with pointing out the certainly obvious (but, under *intraconcretionary* conditions, less certainly competent) agencies of weathering and chemical corrosion as the reasons for the observed absence of meteorites in the earlier geological formations and more concerned with actively searching for traces of such bodies in impervious types of concretions taken from these formations.

In conducting such searches, it must be kept in mind that *imperviousness* of the concretions studied is all important. Bramlette[3] has cited an interesting case in which of two closely adjacent concretions, one was "not as dense and impermeable" as the other. In this less impervious concretion, it was found that "the abundant biotite was nearly as much altered . . . as in the adjacent sand," whereas the biotite was black and little altered in the nearby dense and impermeable concretion. In addition to the important factor of imperviousness, it is desirable to work with as large numbers of as big concretions as possible in order to increase the probability that meteoritic materials falling at random from the skies will have found lodgment in the concretions examined. The laboratory techniques (crushing, sieving, centrifuging, *&c.*) to be applied in analyzing concretionary contents are thoroly treated in the standard works on heavy-mineral analysis and sedimentary petrography.[4]

As regards the meteoritical evidence to be looked for in concretionary contents, it may be classified as: (1) *megascopic,* (*2*) *microscopic,* and (3) *analytic.*

Megascopic evidence would be furnished by the discovery inside concretions of pieces of meteorites (or tektites), visible to the naked eye or under a hand lens, that had survived in recognizable form because of the protection against weathering and corrosion afforded by the concretionary shell. Actually, the so-called "volcanic-glass shards," found in some abundance by Bramlette inside calcareous concretions taken from the Hambre sandstone of Miocene age, may be, conceivably, pieces of tektites, for the scant data on the physical properties of the shards so far published by no means exclude a tektitic origin for these glass fragments.

Microscopic evidence would be supplied by finding in concretions either submacroscopic fragments of meteorites (or tektites) or such probably meteoritic substances as the minute, magnetic particles of globular shape found in deep-sea deposits,[5] or of spherical and cindery form found in cosmic dust collected from the atmosphere.[6] Such evidence would be provided also by the isolation and identification of such definitely nonterrestrial minerals as moissanite (meteoritic SiC), schreibersite, and daubréelite. Among such minerals, moissanite, because of its extreme durability and stability, naturally suggests itself as the test mineral, *par excellence.* Unfortunately, use of this otherwise ideal test mineral is possible only if the experimenter takes extraordinary precautions, because of the world-wide distribution of its artificial congener, carborundum. The hazards incident to the use of moissanite as a test mineral are well illustrated by the experience of Ohrenschall and Milton, who, in 1931, published a paper on their supposed discovery of moissanite in heavy-mineral residues from oil-well cores.[7] In 1932, their identification of this substance as meteoritic SiC was questioned by Edelman,[8] who pointed out that, by very careful laboratory procedures, it had been possible, in every case of which he had knowledge, to trace the occurrence of supposed moissanite in heavy-mineral residues to contamination resulting from the use of polishing pastes and similar compounds containing carborundum.

In spite of Edelman's trenchant criticism, the belief seems to persist in certain quarters that both Ohrenschall and Milton and Mrs. Fanny Edson, while Subsurface Geologist for the Roxana Petroleum Corporation, actually found and identified moissanite in heavy-mineral residues. Since the matter is of great importance to the meteoriticist, I directed an inquiry to Dr. C. H. Edelman, Director of the Landbouwhogeschool, Afdeling voor Regionale Bodemkunde, Geologie en Mineralogie, at Wageningen, Holland; and, in reply, under date of

1948 December 14, he kindly sent me the following statement, which would seem to settle the issue once and for all:

"There is no question about cosmic moissanite in sediments. In my laboratory, in those of my former pupils and co-workers in Ghent, in Paris, and in the large sediment petrological laboratory of the Royal Shell at Amsterdam, hundreds of thousands of sedimentary rocks have been analyzed under the microscope, and the mineral moissanite is never found unless as contamination, which can easily be controlled. This is the opinion of 30 or 40 scientists who have worked in our line in the last 20 years."

Since meteoritic SiC does occur at the Barringer (= Canyon Diablo, Arizona,) Meteorite Crater, and, according to the very extensive experience of Edelman and his associates, does *not* occur naturally in terrestrial deposits, its discovery within concretions would be quite conclusive proof that these had entrapped and preserved meteoritic materials—provided, of course, that precautions had been taken, precluding the possibility of contamination by carborundum. This same remark would apply with equal force if, at some time in the future, moissanite were discovered at some of the curious cryptovolcanic structures and meteoriteless meteorite craters, the origin of which now seems shrouded in mystery.

Analytic evidence that the resistant nickel-iron alloys of the siderites had probably been present in concretions would be furnished by chemical or spectroscopic proof that these objects are, *e.g., nickel-rich* in comparison with the surrounding sedimentary beds. Under extraconcretionary conditions, it may be presumed that the leaching away of the nickel content of meteoritic iron and the subsequent deterioration of the meteoritic material into an unrecognizable form would be completed in short periods of time, geologically speaking. On the contrary, within impervious concretions, nickel leaching might be so retarded that, even after millions of years, the extremely sensitive nickel tests now available would detect the presence of this element.

In connection with the analytic identification of extremely small quantities of ferrous and ferric iron, nickel, cobalt, copper, and other metallic elements in concretions, as in the analogous problem for the presumably cosmic magnetic dusts collected from the atmosphere, urgent need exists for improvements on and extensions of the standard dimethylglyoxime test. For some time, a project for the development of a *suite* of precisely such ultrasensitive tests has been under way in the Research and Development Division of the New Mexico School of Mines at Socorro, under the supervision of Dr. William D. Crozier. New tests employing organic reagents have been devised, and, as perfected, these have been tried out on typical samples of meteoritic dusts supplied for the project by the Institute of Meteoritics of the University of New Mexico. Oral and written reports on the results obtained from such testing, recently received from Dr. Crozier, are most encouraging. It seems very probable that extremely sensitive, new analytical tools will soon be added to the meteoritical armamentarium.

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[2] Bramlette, M. N., *Jour. Sedimentary Petrology*, **2**, 32-6, 1941; and Boswell, P. G. H., *Nature*, **147**, 734-7, 1941.

[3] Bramlette, M. N., *loc. cit.*, ([2]), p. 34.

[4] Consult Boswell, P. G. H., *Mineralogy of Sedimentary Rocks*, London, 1933; Krumbein, W. C., and Pettijohn, F. J., *Manual of Sedimentary Petrography*, New York, 1938; and Milner, H. B., *Sedimentary Petrography*, London, 1940.

[5] Murray, J., *Geog. Jour.*, **19**, 693-711, 1902; Murray, J., and Hjort, J., *The Depths of the Ocean*, 154-5, London, 1912.
[6] Rudaux, L., *La Nature*, **58**, 439-43, 1930, and **61**, 436-7, 1933.
[7] Ohrenschall, R. D., and Milton, C., *Jour. Sedimentary Petrology*, **1**, 96, 1931.
[8] Edelman, C. H., *Jour. Sedimentary Petrology*, **2**, 48, 1932.

Use of Meteor, Meteorite in Astronomy Cleared Up

Inquiries are occasionally received regarding the terms "meteor" and "meteorite." Both are commonly employed, but some persons are never sure about which one to use. Occasionally we hear the whole thing boiled down to the two-syllable "meter," which is perfectly legitimate in connection with the use of water and electricity, but has no place in the naming of "stones that fall from the sky"!

The brilliant objects that at times are seen tearing across the heavens, producing considerable noise and perhaps actually reaching the Earth as solid pieces of stony or metallic material, are likely remnants from some ancient, disrupted planet.

The general tendency at present is to consider that the original planet existed between the orbits of Mars and Jupiter, and that, since its breakup, the larger masses have encircled the Sun as the present asteroids and that the wandering smaller bits account for our atmospheric fireballs.

Three Terms Used.—The small "shooting-stars," which burn completely to ash high in the air, are seemingly disintegration products of comets. Swarms of them are known to travel in cometary orbits.

Until a few years ago, it was common practice to use three terms in describing these celestial visitors to our Earth's atmosphere. When far out in interplanetary space and speeding toward the Earth at 20 or 30 or 40 miles per second as a cold, non-luminous object, one of these masses was given the name "meteoroid."

When it got down to within 100 miles or less of the Earth's surface and began to flare into luminosity from the heat generated by friction with our atmosphere, it was said to change to a "meteor."

If a central core withstood the fiery ordeal and reached the Earth as a dark, solid chunk, it finally became a "meteorite." Thus, it could exist in all three states, in name at least, within a very few seconds!

Meteorite Solid Mass.—Dr. Frederick C. Leonard, head of the Department of Astronomy at the University of California at Los Angeles, and a world authority on matters such as we are discussing, has been attempting, in the past few years, to reduce the terminology to two words with definite meanings and without hypothetical changing during a few seconds of time. The present writer is in full accord with these efforts.

To Dr. Leonard, a meteorite is at all times the solid mass, whether it is flying invisible thru cold space millions of miles from the Earth, or is passing thru our atmosphere with a flaming exterior, or is finally resting on—or in—the Earth's surface, again as a cold object. The term "meteor" applies solely to the luminosity that results when the meteorite is in flight thru the air.

We see the shining meteor in the sky, but a meteorite at its core is causing the commotion. We actually see the meteorite only after it has landed on the Earth or is falling as a dark object near the Earth's surface.—J. Hugh Pruett, Astronomer, Extension Division, Oregon Higher Education System, Eugene, in *The Oregonian*, Portland, Oregon, November 27, 1949.

The Meteoritic Fall at Sikhote-Alinsk, U.S.S.R. (ECN = ∓ 1347,462)

The following item is quoted from *Sky and Telescope,* **9**, 5, Nov., 1949: "in [a German journal,] *Sternenwelt,* for August, 1949, there is a brief note attributed to W. G. Fessenkoff concerning the meteorites that fell at a mountain site in Sikhote-Alinsk, southeastern U.S.S.R., on February 12, 1947 [at 0^h38 U.T.]. The meteorite swarm gouged 120 craters with diameters up to 28 meters; some of the crater profiles have been measured. It is estimated that the total mass may have amounted to 1,000 tons. If all of this material were concentrated in one ball at 3 times the distance of the Moon, it would appear like a planet of the 15th magnitude, the note states. The geographical coördinates of the fall are given as 134° 39′.7 east, 46° 9′.6 north."

The J. Lawrence Smith Medal Awarded to Dr. Fred L. Whipple

According to *Science,* **110**, 489, Nov. 4, 1949, "The J. Lawrence Smith Medal of the National Academy of Sciences has been awarded to Fred Lawrence Whipple, Chairman of the Department of Astronomy of the Harvard Observatory. Dr. Whipple received the award in recognition of his research in the field of the motions and nature of meteoritic particles in the Earth's atmosphere, and especially for his derivation of the variations of air temperature with altitude, based on his studies of meteors." The congratulations of the Meteoritical Society, of which he is a Councilor, go to Dr. Whipple on his receipt of the Smith Medal.

President of the Society: Arthur S. King, 925 Topeka Street, Pasadena 6, California

Secretary of the Society: John A. Russell, Department of Astronomy, University of Southern California, Los Angeles 7, California

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By MARGARET W. MAYALL, Recorder

It seems fitting to devote part of this first number of Variable Star Notes by the new Recorder to an appreciation of the Honorary Recorder, Leon Campbell. Since 1925 his name has been very familiar to readers of Popular Astronomy, first as the Recording Secretary of the AAVSO and later as Recorder and author of this valuable series of notes on variable stars. At the 1949 Annual Meeting of the AAVSO, Mr. Campbell was elected Honorary Recorder, and although he is officially retired from active duties, he will continue his research on the light curves of long period variables.

Notes on R Coronae Borealis-type stars: R Crb, 154428. After a very long, deep minimum, R Coronae Borealis is gradually rising to maximum. It had a still-stand of about 50 days around the 9th magnitude, but about the middle of October started to rise again, until it is now a little brighter than the 8th magnitude. In the September, 1949, issue of the *Astrophysical Journal* (Vol. 110, No. 2, p. 143) George H. Herbig of Yerkes and McDonald Observatories, discusses its changes in spectrum during the 1948-49 minimum. Very few observations had ever been made of the spectra of R Coronae stars during minimum phase. At maximum,

LEON CAMPBELL
HONORARY RECORDER, A.A.V.S.O.

R Coronae Borealis has a spectrum similar to a supergiant F5 or F8. No changes were observed in the spectrum until the star was down to about the 10th magnitude, when emission cores appeared in the H and K lines. These strengthened toward minimum light and other low excitation lines appeared. The question is raised as to whether the diminution of light may be caused by a low temperature shell. At no time did he find any trace of hydrogen emission. Mr. Herbig reproduces a light curve from AAVSO observations.

S Aps, 145971. Seems to be on its way back to maximum. The first of November it had increased to 11th magnitude.

SU Tau, 054319 and TY Sgr, 191033. Both still at maximum brightness.

SS Cygni-type variables: SS Aur, 060547. A maximum was observed at about JD 2433212.

U Gem, 074922, had a maximum around JD 2433240.

Z Cam, 081473, remains fairly constant at about 12th magnitude.

UU Aql, 195109. No observed maximum since JD 2433123.

SS Cyg, 213843. Wide maximum observed at about JD 2433190, magnitude 8.4, and a narrow maximum at JD 2433251, magnitude 8.3. One of our newest observers, Capt. William H. Galbraith, is the only observer, so far reporting, who caught SS Cygni on its way up to its latest maximum. Scattering of observations at minimum light is much greater than usual, from 11th magnitude to 12th magnitude. Several observers have reported changes within a few hours.

Notes on a few interesting variables. T And, 001726. Faint and near minimum, during November and December.

S Cet, 001909. A still-stand around magnitude 10.

RZ Per, 012350. Faint and near minimum, the last of November.

U Per, 015254. Beginning to fade early in December, after a broad maximum.

W And, 021143a. Near maximum, in December.

R Aur, 050953. Fading rapidly during November.

R Car, 092962. A very flat maximum, beginning JD 2433150.

S Car, 100661. A deep minimum in November, following the previous two shallow ones.

T UMi, 133273. Well observed throughout minimum, magnitude 13.4, JD 2433180.

X Her, 155947. A semi-regular variable. Observed maximum, magnitude 5.8, JD 2433185.

Nova Sct 1949, 185004. Fainter than 13th magnitude since JD 2433205.

RR Tel, 195656. Very peculiar. After four years of maximum brightness, at about 7th magnitude, it faded from 7.0 on JD 2433150 to 8.0 on JD 2433200. Should be very carefully watched.

Observations received during November, 1949: During the month of November, the AAVSO has received 5,260 observations from 68 observers, as follows:

Observer	No. Var.	No. Ests.	Observer	No. Var.	No. Ests.
Adams	29	63	Kirchhoff	35	67
Ahnert	30	228	Knowles	4	4
Ancarani	22	45	de Kock	119	387
Armfield	4	7	Kratz	4	4
Bogard	64	157	Lacchini	85	122
Buckstaff	9	15	Lankford	13	30
Bufkin	12	12	LeVaux	1	1
Burkhead	1	1	Lowder	5	5
Cain	5	5	Luft	7	31
Chandra	44	54	Melville	5	26
Charles	13	16	Miller	19	19
Chassapis	189	376	Oravec	66	97
Cragg	31	32	Parker	34	42
Daley	12	19	Parks	19	19
Darling	11	12	Pearcy	105	108
Darnell	2	7	Peltier	178	247
Diedrich, DeL.	1	1	Penhallow	36	49
Diedrich, G.	3	4	Pierson	54	57
Dillon	11	22	Plakidis	10	18
Drakakis	49	541	Pocher	1	16
Escalante	75	100	Reeves	2	6
Estremadoyro, V. A.	4	4	Renner	183	183
Fernald	315	920	Rosebrugh	17	76
Focas	30	38	Sill	28	28
Ford	7	7	Stevens	14	14
Galbraith	9	105	Taboada	105	115
Greenley	72	129	Tifft	5	5
Haage	1	13	Toche	5	10
Hamilton	15	21	Upjohn	44	45
Hartmann	157	187	Venter	8	10
Herring	49	93	Webb	21	21
Hiett	12	22	Weber	30	30
Hirose	16	64	Yamada	12	30
Holloway	5	7	—		—
Kelly	11	11	68	totals	5,260

December 15, 1949.

Comet Notes

By DANIEL L. HARRIS III

PERIODIC COMET REINMUTH (1), 1929 I, which was mentioned in the notes earlier this fall, was recovered by Mrkos of the Skalnate Pleso Observatory on the 19th of November. This comet, which has received the designation 1949 *f*, was found very close to the predicted position and it appears that perihelion passage will occur on 22 July 1950. At the present time it is of the 18th magnitude.

Another new comet was discovered on 19 November by Wilson and Harrington of the Mount Wilson and Palomar Observatories. This 16th magnitude comet has not received a designation as yet.

To date (10 December) there have been four new comets discovered and one periodic comet recovered this year. It is of interest to compare these numbers with the corresponding numbers for the past four years (we do not count COMET SCHWASSMANN-WACHMANN (1) and COMET OTERMA which are visible every year).

Year	New Comets Discovered	Periodic Comets Recovered
1945	4	4
1946	4	5
1947	9	5
1948	10	2
1949	4	1

It will be noted that 1947 and 1948 were outstanding in regard to the number of new comets discovered and that 1949 is an average year in this respect. It is still possible that PERIODIC COMET VÄISÄLÄ (1) will be recovered this year.

Warner and Swasey Observatory, East Cleveland, Ohio.

General Notes

As stated in the December issue, this issue has been delayed in order to include in it the report of the Tucson meeting of the American Astronomical Society. The writer approached Tucson by a rather circuitous route. On his journey he traveled by way of Mexico City, and spent ten days there. While there, he had the pleasure of visiting the relatively old Observatory at Tacubaya and also the relatively new Observatory at Tonanzintla, near Puebla. At both places he was cordially and very hospitably received and his visits were made most pleasant. Also while there he had the unusual privilege of spending a night at the base of the recently formed volcano, Paracutin, at a time when it was quite active. EDITOR.

Dr. F. L. Whipple, Chairman of the Department of Astronomy, Harvard University, has been awarded the J. Lawrence Smith Medal by the National Academy of Sciences. The award was made to Dr. Whipple in recognition of his acknowledged leadership in the field of motions and nature of meteoric particles in the earth's atmosphere. Dr. Whipple is well known for his theoretical work in the study of meteors.

Dr. Helen Dodson, by action of the Board of Regents of the University of Michigan, has been elected to the position of Associate Professor of Astronomy

in the University of Michigan, effective July 1, 1950. At that time, Miss Dodson will conclude her present part-time appointment at Goucher College, Baltimore, and will then devote full time to the solar research she has been doing at the McMath-Hulbert Observatory at Lake Angelus.

Dr. William F. Meggers, Chief of the spectroscopy section of the National Bureau of Standards, has been elected President of the Optical Society of America at the Society's thirty-fourth annual meeting. The Optical Society serves as a common meeting ground of physicists, chemists, physiologists, psychologists, engineers, and mathematicians in the general field of optics. Election to the presidency is the highest honor the Society can render to a scientist in this field.

Solar System Theories Presented

On January 10, at a dinner meeting of the Chicago's Citizens Board of the University of Chicago held at the Blackstone Hotel in Chicago, several recently developed theories relating to the formation of the solar system were discussed by their proposers. Four members of the faculty of the University took part, namely, Dr. Gerard P. Kuiper, professor of astronomy, Dr. Carl von Weizsäcker, visiting professor of theoretical physics, and Dr. Harold Urey and Dr. Harrison Brown, both of the University's Institute for Nuclear Physics.

The Black River Astronomical Society

The above is the name of a new organization formed on October 7, 1949. It has for its purpose, as stated in its *Bulletin,* Vol. I, No. 1, the bringing together of those people in and about Lorain and Elyria (Ohio) who are interested in astronomy and allied sciences. The tentative schedule provides for meetings on the second Monday of each month at Clearview School. The officers of the new society are: L. E. Armfield, President; William Mason, Vice President; Louis Rick, Secretary; and William C. Roe, Treasurer. Walter Evans, Jr., is the editor of the *Bulletin.* Persons interested should send inquiries to Black River Astronomical Society, Box 231, Lorain, Ohio.

Close Approach of Mars and Saturn Observed

The two planets rose shortly after midnight, and were observed at 6 o'clock on the morning of November 30 when close to the meridian. They were far from "difficult to separate with the unaided eye." Mars was perhaps 12 minutes of arc to the west and slightly to the north of Saturn, although this estimate was only visual, no instruments being available to this observer at the time.

The following morning (December 1) the planets first became visible at about 1:30 when they emerged from the haze which hangs over the city on all but the very clearest nights. At that time Mars appeared to be about 8 minutes of arc directly east of Saturn. There was still of course no doubt at all that there were two planets there.

The actual conjunction must have occurred around 6 P.M., E.S.T., on November 30, at which time the planets were near the nadir of their arc for an observer in the eastern United States. At conjunction their separation must indeed have been small, quite possibly less than 1 minute. A report of the occurrence would be of considerable interest, especially since it was visible only in longitudes not readily accessible to astronomers of the Western World.

C. STANLEY OGILVY.

International House, New York City.

Provisional Relative Sunspot Numbers for November, 1949*

1	120	11	125	21	161
2	130	12	133	22	138
3	97	13	129	23	118
4	120	14	80	24	156
5	135	15	124	25	143
6	116	16	133	26	153
7	118	17	167	27	170
8	130	18	172	28	152
9	157	19	147	29	199
10	125	20	124	30	197

Mean Value for November
R = 139

*From the Zürich Observatory, furnished by Mr. Neal J. Heines.

The Frank R. Seaver Laboratory at Pomona College

The recently completed astronomy laboratory of the Frank P. Brackett Observatory at Pomona College will bear the name of Frank R. Seaver, member of the Pomona College board of trustees and a graduate of the class of 1905. In announcing the name for the Seaver Laboratory, President E. Wilson Lyon also said that the 12-inch Cassegrain reflector telescope installed in the observatory will be named in memory of the late Clara Whitney Shatto, whose interest in the astronomy department extended over many years. The new laboratory was completed this fall at a cost of over $20,000. The building includes a first floor library, classroom, research room, and office, and houses the telescope and dome on the second floor. Construction was possible largely through the generosity of Mr. Seaver.

President Lyon pointed out that the facilities of the Seaver Laboratory combined with those of the Brackett Observatory give Pomona College outstanding equipment for the undergraduate study of astronomy.

Astronomischer Jahresbericht

The following information regarding the "Astronomischer Jahresbericht" has recently come from Dr. A. Kopff, Director of the Astronomisches Rechen-Institut. Of the "Astronomischer Jahresbericht" which is being prepared by the Astronomisches Rechen-Institut at Heidelberg the status is as follows:

Already published,
Vol. 44 (Literature of 1942)
Vol. 45 (Literature of 1943-46, First Part)
In press,
Vol. 47 (Literature of 1947)
The manuscript has been finished for,
Vol. 46 (Literature of 1943-46, Second Part)
Vol. 48 (Literature of 1948)

Orders for any of these may be placed with Verlag W. de Gruyter, Berlin W 35, Genthinerstr. 13, the publisher of the "Astronomischer Jahresbericht."

The Cleveland Astronomical Society

As in many previous Christmas meetings, the speaker at the meeting of December 9 was Mr. David Dietz, science editor of the Scripps-Howard newspapers and Pulitzer prize winner. Mr. Dietz is a popular speaker and an over-

flow crowd of about 150 was present in the Warner Auditorium of the Warner and Swasey Observatory of Case Institute of Technology.

Although the speaker's topic was "Science in 1949," the major portion of his speech was naturally devoted to astronomy. As a preliminary, it was noted that this is a good year to test some of the theories concerning the Star of Bethlehem, due to the brilliance of Venus, its recent conjunction with Jupiter, the close conjunction of Mars and Saturn near December 1, etc. Among the important developments mentioned were the completion of the re-grinding of the Hale 200-inch telescope mirror, the increasing importance of the Schmidt-type telescopes and photoelectric cells, the start of construction of the 120-inch reflecting telescope at the Lick Observatory and the 98-inch reflecting telescope in England, and the increased use of large, fast electronic computers. Also mentioned was Kuiper's work on the solar system, particularly on the rings of Saturn and the discoveries of the new satellites around Uranus and Neptune.

Among other scientific high-lights discussed by the speaker were the development of the "breeder" type of nuclear reactor, the publication of the book "Cybernetics" by Prof. Norbert Wiener, and the discovery of cortisone. The failure of Congress to establish a National Science Foundation was deplored.

Following this worthwhile review, Mr. S. K. Towson, of the Elwell-Parker Co., presented his telescope-building cash prizes to Mr. Safron Kanja, Mr. Al Isaac, and Miss Anne Hitchko. Also Mr. Maynard Murch, as a trustee of the Cleveland Museum of Natural History, presented cash prizes for essays on the topic "What I Could Do With a Six-inch Telescope." First prize went to Mr. James Snyder (age 14) and second prize to Mr. Craig Starrt (age 11).

Carol singing and refreshments were the traditional adjuncts to this interesting program.

PAUL ANNEAR, *Recording Secretary*

Burrell Observatory, Baldwin-Wallace College, Berea, Ohio.
12 December 1949.

The Hale Telescope in Operation

The 200-inch mirror for the Hale Telescope has been aluminized, put back in the telescope and the first new test photographs made with the giant instrument, Dr. Ira S. Bowen, Director of the Mt. Wilson and Palomar Observatories, announced recently.

After study of the new pictures by the observatories staff, Dr. Bowen said, "These photographs leave no doubt that the Hale is a thoroughly successful instrument. It is going to do the work for which it was designed. The full gain of the 200-inch over the 100-inch (next largest) at Mt. Wilson will not be realized, however, until a Ross corrector lens now being made has been completed and installed. This lens will give the Hale the same focal ratio as the 100-inch and we will then be able to get accurate comparable photographs." The focal length of the 200-inch is 55 feet (666 inches) as compared to 42 feet (500 inches) for the 100-inch. Early plans to design the Hale with the same focal ratio as the 100-inch were abandoned and the Ross corrector lens principle adopted because of the tremendous structural problems involved.

The fact that this auxiliary equipment must still be completed and installed will not delay the beginning of a search of the heavens with the 200-inch, however, and much of the work the astronomers have been waiting to start can now get underway. Immediate plans call for photographing of many standard objects

such as relatively nearby galactic and extra-galactic nebulae, star clusters, nebulae clusters, and others previously photographed by the 100-inch.

The first spectrographic work is expected to begin in March. This will be done at the prime focus. The Coudé spectrograph is not yet completed. This work will be aimed at obtaining additional information on velocities of nebulae—the speed at which these huge island universes like our own Milky Way are moving out in space millions of light years from the earth. There will also be direct photograph work at the prime focus designed to obtain more information on the number of nebulae and their distribution in space, and some additional work on the shape and form of planetary nebulae during the first year, Dr. Bowen said.

Most of the problems that harassed the astronomers last year when they first tested the Hale have been solved. High spots over an area of some 20 inches around the outside edge of the mirror's surface were removed last summer. Difficulties with the adjustment of the mirror to temperature changes have been pretty well overcome by installation of a system of fans in the cell which holds the big disc plus insulating its outer edge. More of the latter remains to be tried, but Dr. Bowen and his staff no longer consider this a critical problem. The support system, which gave trouble last year, was subsequently modified and is now working satisfactorily.

Much remains to be done by way of installing auxiliary equipment. This will go on for the next two or three years, but will not hold up operation of the telescope. It will merely limit its uses until such additional equipment is completed and installed. Largest of the remaining projects to be completed is the Coudé spectrograph. *(From a California Institute of Technology News Release)*

Book Review

From Euclid to Eddington, by Sir Edmund Whittaker, F.R.S., Tarner Lecturer, and formerly Fellow, of Trinity College, Cambridge. (Cambridge University Press, New York, 1949; $4.00.)

In 1947, Sir Edmund Whittaker, Professor of Mathematics in Edinburgh University and formerly Fellow of Trinity College, Cambridge, gave the Tarner Lectures at Trinity College. The substance of these lectures has now been made available in "From Euclid to Eddington." A subtitle characterizes the book as "A Study of Conceptions of the External World," which might suggest to the reader a review of modern conceptions of the cosmos, a summary of present-day physical theory, or, possibly, a treatise in the philosophy of science. But none of these possibilities was the author's aim, which was rather to present a brief study of the development of certain concepts and theories, particularly those which have aided in the synthesis of scientific thought, and about which controversies have been waged. They include the concepts of space, time, movement, mass, weight, energy, aether, and momentum; the theory of relativity, of gravitation and electromagnetism, and of quantum mechanics; and the principle of equivalence, the uncertainty principle, the exclusion principle, and Eddington's principles.

The book is a stimulating piece of scientific exposition for the educated layman who has had some training in modern physical science. It brings him a brief view of the developing concepts and theories of modern physical science and stirs his imagination with suggestive hints of a new unification of physical theory and a

new geometry of the cosmos. Though the subject matter is rather advanced, in only a few instances does the author employ a mathematical presentation. Like the lectures of certain foremost scholars to their graduate students, his work contains a number of hints and suggestions for further study which the inquiring reader would like to see more fully developed. To some persons perhaps one of the most valued aspects of the book will lie in these hints. They indicate glimpses into a mind well stored with historical data, and serve to provoke one to further thought.

The reader of Whittaker's "History of the Theories of Aether and Electricity" will recall his clear, buoyant style of writing and his detailed acquaintance with the history of scientific concepts and theories. The writing of the present volume is marked by the presence of these same characteristics, as exemplified in his account of the history of the concept of space, the development of the dynamics of motion, and the exposition of electron-spin. Though the information given is familiar to those who have interested themselves in the history of science, it is, nevertheless, helpful in brief compass to find a well-coordinated statement of the development of particular concepts and principles.

For the astronomer, perhaps the chief interest in the book may be in the story of these basic concepts and principles of modern physical science, their significance as means of effecting a unification of physical science, and their possible effect upon cosmological theory. In the last part of the volume, after correcting some common misunderstandings of the work and method of Eddington, the author gives an exposition of his principles and shows how they apply to contemporary cosmological theory. He says that Eddington's theory of the structure of the universe has a large measure of support, in that it has a close connection with "his theory of the constants of nature," and that it is "the most detailed and the best defined." As such, his geometrical theory provides a basis "for a correct representation of the material world." In this connection Whittaker compares "the work of unification achieved by Eddington" with that of Maxwell in electromagnetic theory. To some readers this part of the book may hold a surprise; for others it may be considered as a fair and clear statement of the present-day case for cosmological theory.

The subject matter is arranged conveniently under seventy-three topics grouped in five main parts: Part I. Space, Time, and Movement; Part II. The Concepts of Classical Physics; Part III. The Concepts of General Relativity; Part IV. The Concepts of Quantum Mechanics; and Part V. The Eddington Universe. The text and format of the book are excellent examples of the good printing characteristic of the Cambridge University Press.

Leo E. A. Saidla.

Polytechnic Institute of Brooklyn, Brooklyn, New York.